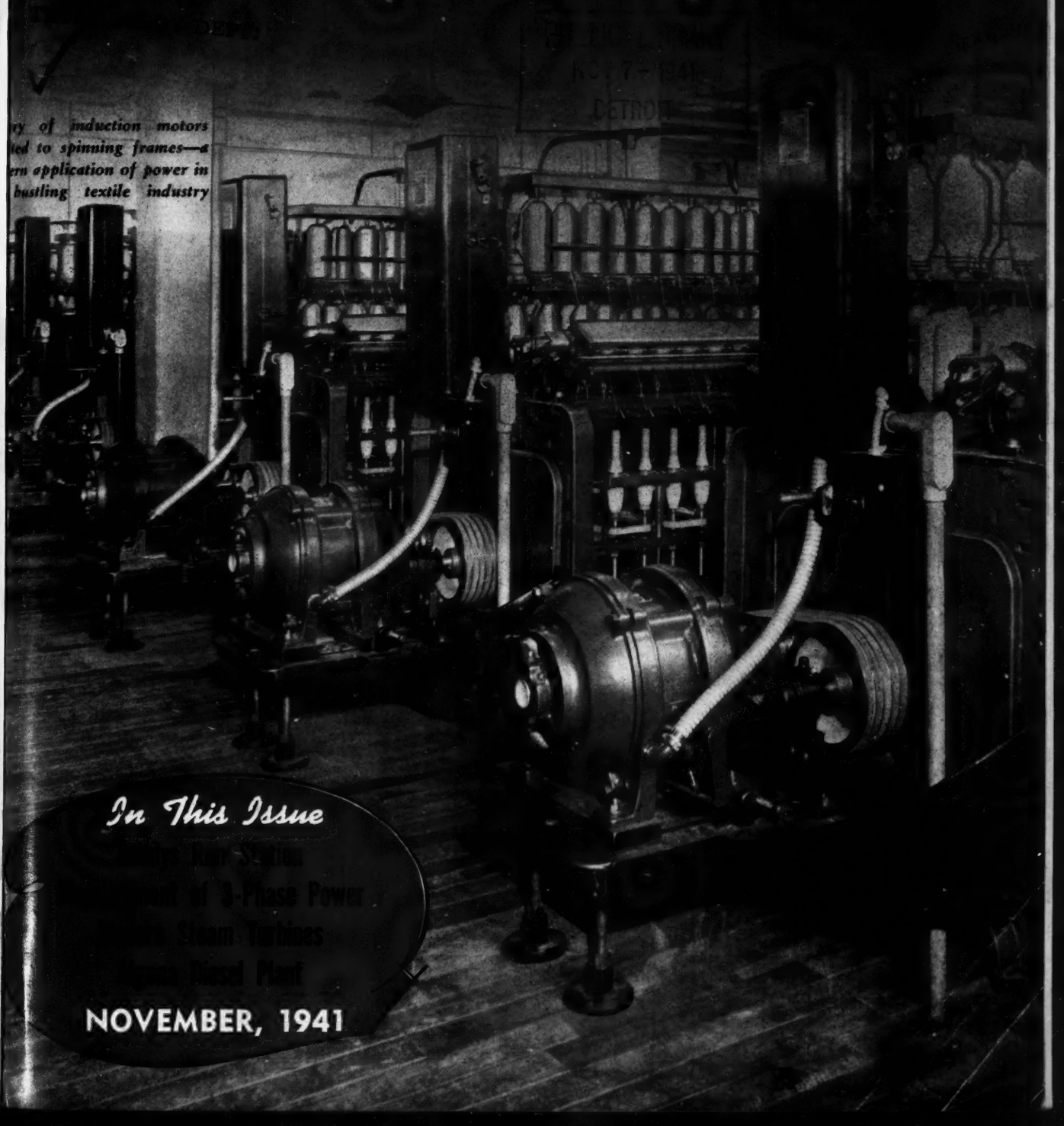
POWER PLANT ENGINEERING

THE PLANT ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



...ry of induction motors ...ted to spinning frames—a ...ern application of power in ... bustling textile industry

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...of 3-Phase Power

...Steam Turbines

...Diesel Plant

NOVEMBER, 1941

Big plants, small plants

ELLIOTT DEAERATORS

. . . . front line

POWER PLANT ENGINEERING

NOVEMBER, 1941
VOLUME 45, No. 11

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PUBLISHED MONTHLY BY
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.

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CLEVELAND: George E. Andrews
11733 Edgewater Dr., Lakewood, O.

Subscription price $2.00 a year in the United States and Possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copy current issue 25c; back issue 40c.

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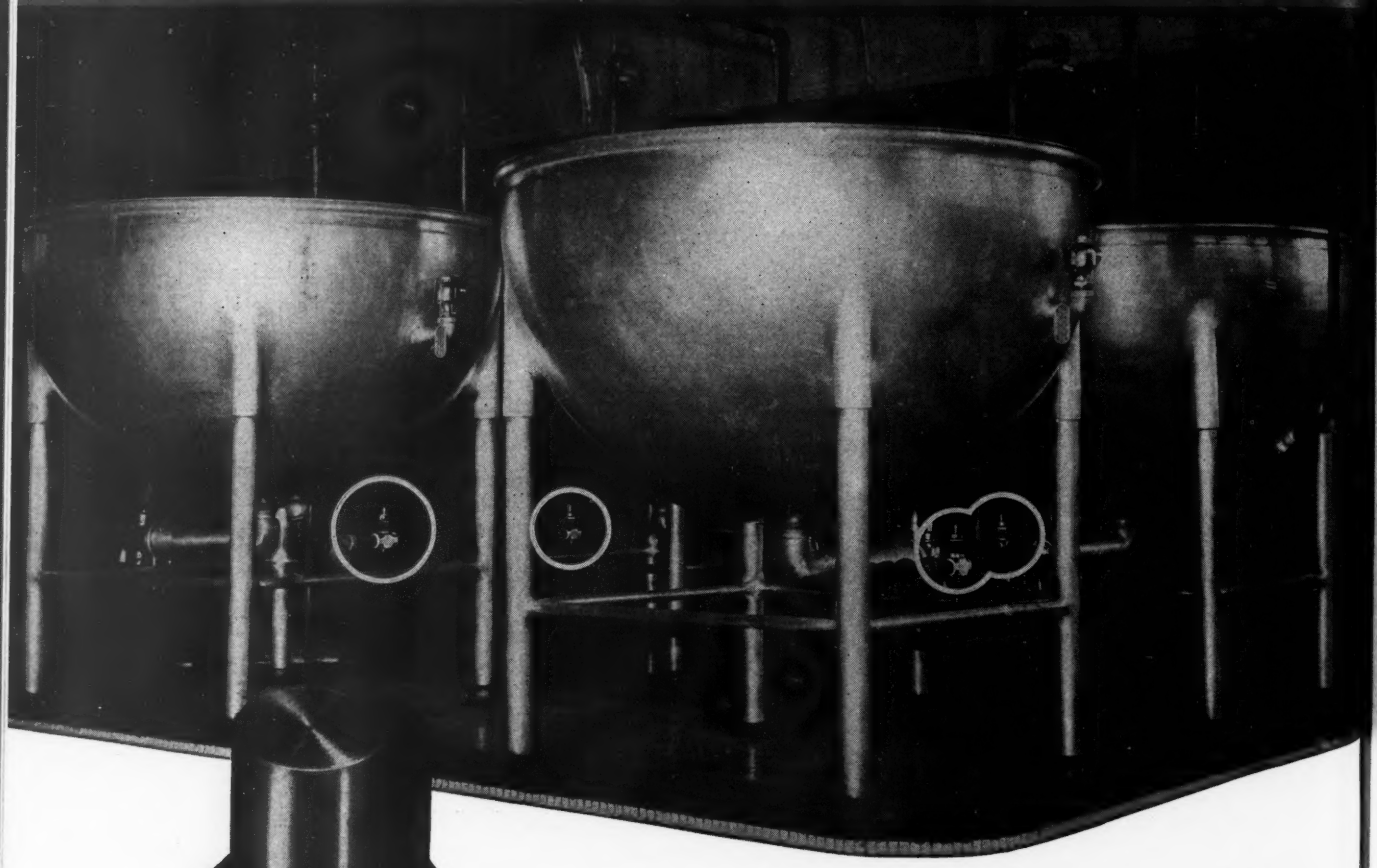
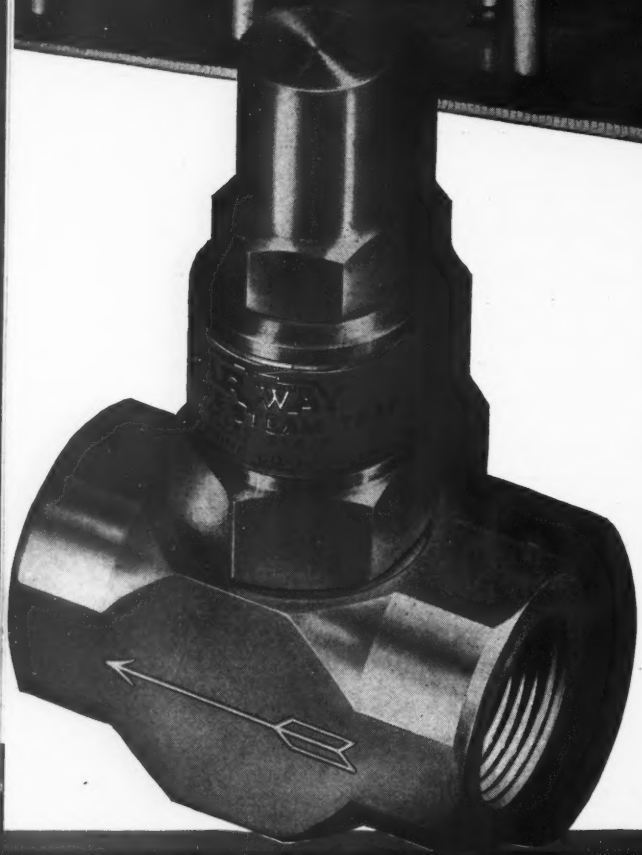
Rx for Quick Cooking at North Carolina State Hospital





YARWAY IMPULSE TRAPS

YARWAY IMPULSE TRAPS have put new life in many a "sick", sluggish, water-logged kettle. In fact they are "good medicine" for the profitable operation of steam equipment of all kinds because their *quicker heating* and *greater sustained heating efficiency* speed up production and save fuel.

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YARWAY IMPULSE STEAM TRAP

PRODUCE MORE WITH WHAT YOU HAVE

Says HUBERT L. CONSLEY

IT is now difficult if not impossible to secure equipment, it takes time to train men, therefore, we as engineers and manufacturers, must find ways to do more with what we have if we are to be successful in the National Defense Program. That this can be done has already been proven in our sheet metal shop which now employs 150 to 200 men. It is not a big production shop, nor is it entirely a jobbing shop.

Our accepted procedure at one time was to furnish engineering drawings to sheet metal workers who used the usual run of equipment found in sheet metal shops. Thus, at the start of our analysis, there were three things that stood out for consideration: drawings; sheet metal workers; and manufacturing equipment. At once manufacturing equipment was eliminated because: it costs money and increases overhead; buildings to house it are needed which in turn cost money and take time to build; it is impossible to secure equipment in a reasonable length of time, if at all.

We then focused our attention on the sheet metal worker, a highly skilled workman and one who stands high in the ranks of skilled labor. Bearing in mind that we were working from engineering drawings, we attempted to set down in black and white, the things that the sheet metal worker actually did and we were surprised at the number and the importance of his jobs.

The record of his activities divided itself into eight jobs as follows: 1, layout; 2, design of joint and construction; 3, selections of operations to be performed; and 4, selection of equipment; 5, planning of the job; 6, set up; 7, machine operations of any or all of the tools in the shop; 8, assembly.

This brought us face to face with the realization of the fact that our problem was one of transferring skill and specialization of jobs. It became evident at once that to do this we must record the skill in some way so that less skilled men could do the job.

This meant that we must furnish the shop with: complete drawings of single pieces in full detail with definite tolerances on each measurement and specification; shear charts showing how to cut the pieces out of the sheets specified; bill of material covering all items required, this to be used as a material requisition; list of the operations and their sequence; name of the department in which the job will be done; list of equipment or work stations to be used; incentive allowance for the set-up and for each operation; scheduled date for each operation.

This would guarantee that all vital information and all work done on each job was recorded so as to eliminate the preparatory work each time the job was repeated in the shop. This was done by using the most flexible sheet metal workers in co-operation with the most flexible draftsmen. Shortly shop drawings, with everything on, were coming through the shop.

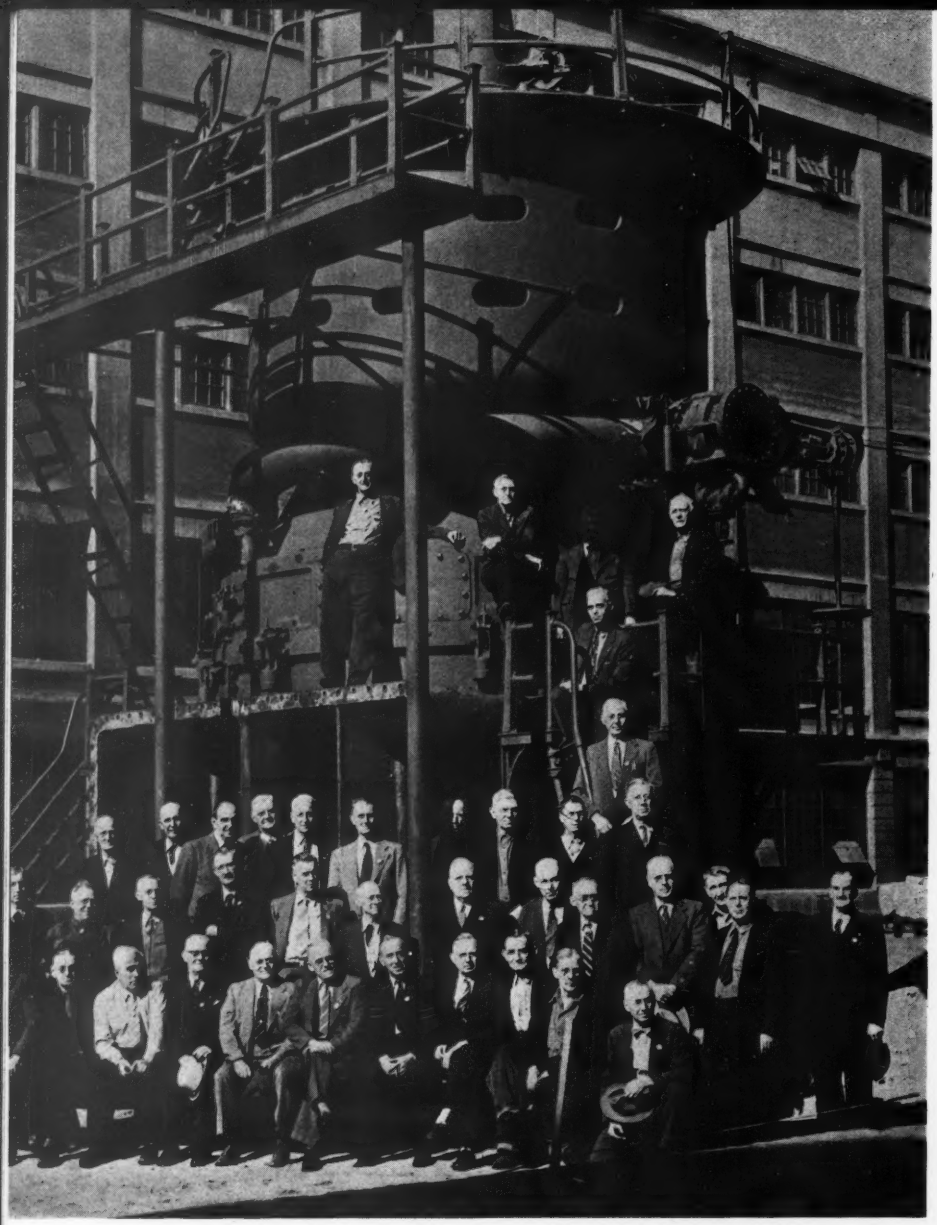
This at once eliminated the first five of the above eight skilled jobs and left only three operations to be done by workmen in the shop. These are: (6) Setting up of tools, presses, brakes, shears, etc., which in reality does not require a sheet metal worker, but rather a specialist who is familiar with the dies, tools, and machinery (these men, in most cases, were trained from helpers and handymen in the shop); (7) machine operating, which again does not have to be done by sheet metal workers (men can be trained within a short time to operate specific tools and not sheet metal working tools in general); (8) the assembly work which was largely a matter of putting parts together in accordance with a predetermined plan and, these men can be trained from new employes of average intelligence in a very short time.

Thus, we were in position to use our trained, highly skilled, and much valued sheet metal workers as foremen, gang leaders, set-up men, instructors, layout men and as methods men. In this way we accomplished the following things: increased greatly the ratio between non-skilled and skilled employes; increased the productive capacity of the equipment; increased the productive capacity of the shop as a whole; decreased by 20 per cent the amount of supervision required in instructing the men how to do the job, because the drawings were simple, plain and complete; simplified materially the job of making time studies; decreased the time required for setting rates by 28 per cent and increased incentive coverage from 30 to 97 per cent which in turn increased production through improved worker effort; found and located interchangeable parts on various units that could be built in stock lots, on some pieces the set-up time was 10 to 20 times greater than the operation time due to the small quantities and this was materially improved by bringing through stock lots of interchangeable parts; reduced the inspection time by approximately 25 per cent; and simplified the planning and scheduling activity to a point that permitted it to really work.

Through this procedure we materially increased the productive capacity of the shop without increasing skilled labor or equipment, and proved definitely that through shop drawings, transfer of skill, specialization of work, and better planning and control, we could "Do More With What We Have."

HUBERT L. CONSLEY, assistant works manager of the York Ice Machinery Corp., since 1935, was born in Mississippi in 1894, graduated from Mississippi State College with a B.S. degree in mechanical engineering in 1914 and immediately joined the York organization. After training in the York college apprentice school, he became chief engineer of an ice and light plant in Bay St. Louis, Miss., for a short time, but late in 1915 returned to York as an erecting engineer.

For a few months in 1916 he was chief engineer of an ice company in Roanoke, Va., but soon returned to the York erecting department. In 1917 he become a sales engineer in the York St. Louis office but at the beginning of World War I, entered the army as a commissioned officer of Ice Plant Company No. 301 and acted as assistant chief engineer of large cold storage food plant in France. At the close of the war, he returned to the York organization. The remarks on this page were taken from a longer address before a meeting of the American Management Association.



MONUMENT MAKERS

TO COIN A PHRASE, a lot of steam has passed over the buckets since these men helped build this 5000-kw. vertical shaft turbine for the Commonwealth Edison Company in 1903. A landmark since 1909 on General Electric's Schenectady Works Avenue, the "Monument to Courage," as it is affectionately known in the turbine world, was recently moved 20 ft. to make way for a street widening project. The occasion provided a good excuse for a get-together of these 40 old timers who worked on the machine and who are still in G-E's turbine division. When the Chicago turbine was put in service 38 yr. ago, its capacity was ten times greater than any preceding vertical machine, and its massive size was something to behold. If 40 men perched on a modern counterpart of this machine, they would probably hide it completely

WITH THE EDITORS

◆DESTROYING DNIEPERSTROY . . . When a single good shot from a 40 million dollar battleship sends another 40 million dollar battleship to the bottom of the ocean, much as we may deplore the loss of life and wealth, we accept it as one of the inevitable concomitants of war. A battleship is a destructive engine and as such everybody knows that it must take its chances in action for better or for worse. The deliberate though entirely justifiable destruction of the great Dnieperstroy Dam and Power Plant by the retreating Russians is something more difficult to accept, however. Don't misunderstand us; we are entirely agreed that it was necessary for the Russians to destroy the dam and knowing what Dnieperstroy meant to the Russians we can only admire their act all the more, yet it leaves us depressed and disheartened. Dnieperstroy was more than a great power development, it was a symbol of the Russian spirit of accomplishment. No single accomplishment in Russia, despite opinions of the outside world, meant quite as much to the Russians as the building of Dnieperstroy Dam. More than anything else it was the embodiment of the philosophy of collective action as understood by the Soviets. It was a most vital part of the first 5 yr. plan and its construction marked the beginning of the Russian Industrial era. Our own interest in the project though detached was nevertheless sincere for it was an American, Hugh L. Cooper, who designed it and who supervised its construction. It was a great constructive project and whatever faults the communistic regime in Russia might have had, Dnieperstroy Dam was not one of them. Its forced destruction by the Nazis at the hands of the Russians will always remain a blot on our so called civilization. Its destruction is a loss not only to Russia but to the world as a whole.

◆BEWARE! THE IDES OF MARCH . . . So far, the billions upon billions of dollars that have been appropriated by the Government for defense and lease-lend expenditures have not had a great deal of effect upon the average individual's pocketbook. True, he has been paying more for things—the cost of living has gone up and this year there was an additional 10 per cent item on his income tax for defense, but aside from these, the appropriations have only increased his ability to read large numbers in the newspapers. But next March—next March fifteenth! That is going to be a horse of a different color. On that date, and for many March fifteenths thereafter, all of us are going to dig, and dig deep and all of us had better make sure that we will have something put aside to dig for.

Most everybody, we hope, has heard of the new tax bill that became effective Oct. 1, but how many of you know about how much you will be required to pay in income tax next March? If you don't you had better make it your business to find out because if you don't, you are going to be surprised if not profoundly shocked. Offhand, you are going to pay a tax of approximately 10 per cent of your income after your personal exemption has been deducted. And if you are sufficiently foresighted you will do something to soften the blow next March by putting a little aside each month from now until then. It will be a good idea for you to put some money in the bank each month, or better yet, buy the new interest-bearing tax anticipation notes provided by the Treasury Department for just this purpose.

◆EX-SERVICE . . . When Johnny Comes Marching Home from the army or navy he will want a job, either his old one or a new one. To give him this job is not going to be a particularly easy task; in many instances his old job will have been filled by someone else and despite promises that may have been made when he went to join the army, employers may find it extremely difficult to live up to their promises to give him back his old job. Yet, according to the Selective Training and Service Act, former employers of these returning soldiers are "required to restore them to their former positions or to positions of like seniority, status and pay."

To minimize disturbance and confusion in this process of rehiring the ex-soldier, the Selective Service System has put into operation a carefully studied and organized re-employment program that functions primarily through its local boards. The successful operation of this system, as Brigadier-General Lewis B. Hershey, the Director of Selective Service, points out depends largely upon the full co-operation of the Nation's industrialists and other employers. Not only are employers required by the act to restore ex-soldiers to their former positions, but General Hershey says, ". . . they have a high moral and patriotic responsibility for doing so."

Employers can best aid to re-establish returning soldiers in civil life by working with the re-employment committeemen of their local Selective Service Boards and with their State Employment Officers. General Hershey suggests that they immediately advise these agencies of all jobs they have available.

◆BLACKOUT . . . Imbued with patriotic fervor a number of communities in this country have at various times recently practiced the "blackout". Without questioning the sincerity of the motives underlying these demonstrations they seem a bit on the silly side to many of us and the nation as a whole does not regard them very seriously. In practicing the blackout we are blindly copying an institution which seemed expedient in Europe and it still remains to be proved just how effective the blackout is.

As pointed out in an editorial in the General Electric Review, recently, despite the blackout in Europe, the enemy aviators have little difficulty in finding their objectives. Big cities and even smaller ones can be detected from the air despite the blackout, for cities have a reflection characteristic that differs from the surrounding countryside. Furthermore, espionage signalling with light is aided by the blackout and even though this can be controlled to a high degree the dropping of parachute flares cannot. The blackout is of little value when incendiary bombs produce giant torches in the form of burning buildings.

◆LIGHTUP . . . These elements added to the fact that the blackout greatly reduced a city's nocturnal activity suggest that the blackout is a rather ineffective device and a number of people in this country who have given thought to the subject feel that the blackout is not the solution to the problem of air attack. They believe that what is needed is a glaring canopy of upward directed light. This could be arranged to blind enemy pilots, to obscure and hide important targets and to aid in protecting aircraft pilots in shooting down the enemy.

As indicated by A. F. Dickerson of the General Electric Co. this canopy of light could be created by installing numerous small but powerful searchlights and wide angle floodlights with their beams pointed skyward at different angles.

A revolutionary idea? Perhaps, but not so impractical as it may seem at first. While the light would attract the enemy as a flame does a moth, the glaring lights would confuse the enemy pilots and obscure important targets; in fact decoy lights could be placed in fields surrounding a city to induce bombing where it would be harmless. The lights could be turned on in different areas of the city every night and these changes from night to night would change the apparent pattern of the city.

The U. S. Army in a preliminary test of this plan recently reported that, in flights over a small area surrounded by incandescent floodlights, not even a long viewing tube could penetrate the glare. If air raids ever threaten the United States, we may see the plan in operation.

PADDYS RUN STATION

For Defense and Prosperity

At a cost of approximately $6,000,000 for plant and substation facilities the Louisville Gas & Electric Co. is building[1], near the southwestern city limits, the initial section of a 300,000-kw. station in record time to meet the needs of National Defense and give unequaled steam and power service to speed the development of a new permanent industrial section of Louisville. The initial section, with a capacity of 50,000-kw., made up of two 25,000-kw., single boiler single turbine units operating at 650 lb., 900 deg. F., will supply high-pressure steam and electric power to nearby industries and feed into the company's 14 and 69-kv. systems. To handle a river level fluctuation of over 80 ft. at low substructure cost, the station is located on a hill with condenser cooling water supplied by vertical deep-well pumps in a separate screen and pump house as high as a 14-story building. Station design will permit safe operation 5 ft. above the 1937 flood level

By RICHARD H. MORRIS
Engineering Editor

NATIONAL DEFENSE sharply etched against a background rich in early American history[3], an abiding faith in the permanent industrial future of Louisville, and, sound engineering unhampered by precedent, make the new Paddys Run[2] Station of the Louisville Gas & Electric Co. one of the most interesting, and certainly the most colorful, station built during the last decade.

Quite aside from the strictly engineering features, which are bound to have a decided influence on future station design particularly in sections where floods are a factor, the development is of major significance. It is indicative of the vital role that an intelligent, farsighted and public spirited utility management can play both in a national emergency and in the permanent peacetime economy of its local district.

Utilities as a whole have consistently anticipated and provided for normal load increases, but few foresaw, in time to act effectively, the abnormal demands which the European war would create. This the Louisville Gas & Electric Co. (together with two other units[4] of the Standard Gas & Elec. System) did do. During 1939 they not only amply provided for normal load increases, but, anticipating our own national defense efforts had the courage to order additional major equipment long before they knew just when it would be needed, or, where it could be located.

Thus at the start of the defense effort they were in a position to undertake one of the most aggressive steps in utility history—the planned development of a new industrial district predicated on dependable and adequate electric power and steam at rates competitive with any district in the country.

With new defense industries springing up by dozens, opening a new district is not unusual in itself. The significant point of the new Louisville district is that the initial or nucleus industries, while intimately tied in with the defense program, are permanent and will carry over to the post war period.

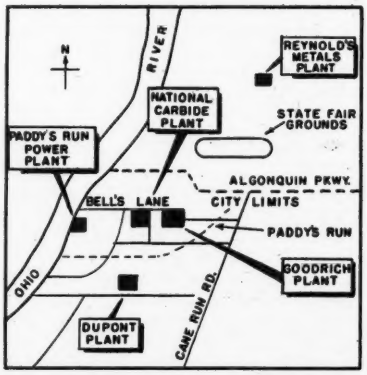


Fig. 1. Sketch map showing the location of the station just outside the southwestern city limits of Louisville. The several industrials shown will require practically the entire capacity of the initial 50,000-kw. The National Carbide plant will supply acetylene, a basic raw product for both the du Pont and one of the two new Goodrich plants for the production of Koroseal. The Reynolds aluminum powder plant is not new

[1] THE STATION was designed by the Public Utility Engineering & Service Co. of Chicago, with the design in direct charge of D. C. Hormell, Mechanical Engineer, and N. C. Pearcy, Electrical Engineer.

It is being constructed by the Louisville Gas & Elec. Co. with L. W. Pickel, the company's Superintendent of Construction, in direct charge. A. W. Lee, Jr., Vice President in Charge of Operation of the Louisville Gas & Elec. Co. merits particular attention and credit for the development because of his confidence in the fundamental soundness of the scheme, his enthusiasm and his untiring efforts in the interests of Louisville and the company. Much credit for the design of the new plant is also due G. R. Armstrong, General Superintendent, and J. F. Hurst, Superintendent Steam Production Department.

[2] PADDYS RUN occupies almost as important a place in Louisville's history as Beargrass Creek upon which the original settlement was located. Originally the creek, which is now largely covered over, started about 3 mi. below the falls and ran well back to what is today the heart of Louisville. The origin of the name is indefinite, although a considerable amount of research indicates that it was named after an Irish fisherman who lived up the little creek and used it on his daily trips to and from the Ohio River.

This is the explanation given by one of the oldest residents of the neighborhood whose father bought a farm there in 1875 while he was a small boy. He learned the story of Paddy and his Run from three aged Negroes who had been slaves of the former owner long before the Civil War and who continued to live in the place after being freed.

[3] Footnotes 3 to 9 inclusive are at the end of the article.

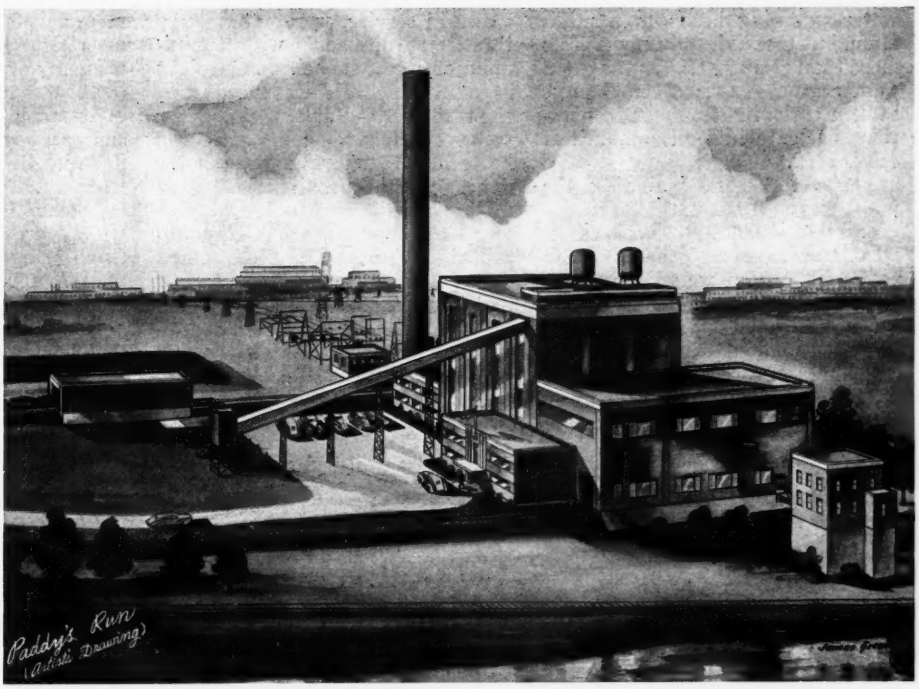


Fig. 2. Artist's drawing of the station which, however, fails to emphasize the distinguishing feature—location on top of a 75 ft. river bank to allow safe operation with river level fluctuations of over 80 ft. The initial section, including the 50 acre site, substation and some additional provisions for expansion (to the right or downstream), is estimated to cost about $6,000,000. Ground was broken in March and operation is scheduled for July, 1942. An additional $2,500,000 is involved in a new 650 lb., 900 deg. F., 25,000-kw. unit just going into service in the company's Canal Station

They are not only new plants, but new industries utilizing synthetic chemistry and producing materials, which, while new, have already demonstrated ability to make and hold a permanent place in our peacetime economy. Louisville already has over 200 small and diversified industries and while ranking 25th in population ranks 17th in industrial output. On a volume basis, however, tobacco and liquor are preponderant and the new industries will do much to give a better balance and stability.

The four nucleus industries which will take practically the entire capacity of the initial section of the new station, circle the plant site as shown by Fig. 1. They are: a du Pont Neoprene[5] plant; a Goodrich Koroseal[6] plant; a National Carbide plant (from which a good share of the output, acetylene,[7] will be sold to the du Pont and one Goodrich plant as primary raw product); and a new synthetic rubber plant for the production of Ameripole[10] and Hi-Car. The Reynolds metal plant is not new but lies in the new district.

Design Background

The new district thus opened offers almost unlimited room for further industrial expansion and the new power plant in the center of the area can be expanded up to at least 300,000-kw. in accordance with future load requirements. While the station is new with the location influenced by commercial considerations brought about by the Defense Program, the design itself is the result of many years' engineering activity, and studies by the company and by the Public Utility Eng. & Service Corp.

In 1937 a 25,000-kw., 450 lb., 900 deg. F. unit was completed in the company's Canal Station, and originally intended primarily as steam standby for hydro capacity. Due to low water, load conditions and the good performance of the new unit, it carried a good share of the system load and in April, 1940 another 25,000-kw. unit was ordered for Canal Station. The same factors which made this unit advisable made it economical to increase the operating conditions to 650 lb., 900 deg. F. This second unit is just now being put into service. The cost was approximately $2,500,000 or about $100 per kw. of rated capacity. Both the 25,000-kw. units are rated at 0.7 p.f. and can be depended upon for appreciable overloads.

Immediately following the President's announcement of the formation of the Advisory Council of National Defense in the spring of 1940, the company placed orders for boilers and turbines for two additional 25,000-kw. units. In order to cut delivery dates these were duplicates of the last unit for Canal Station. The import of this step in providing for 100,000-kw. in capacity within a few months is not apparent until it is realized that the system peak for that year (1940), was only 118,500-kw. (total sales 515,111,000 kw-hr.) and that this additional 100,000-kw. meant more than a 50 per cent increase in generating capacity.[9]

New Site Chosen

It was not until late in February 1941 that final decision on the location of the two new units was decided upon. A steam plant site selected at the time the hydro plant was built at the Falls in 1929 was rendered questionable by the unprecedented flood of 1937. Another site, slightly downstream from the final Paddys Run site was undesirable for the same reason. Serious consideration was also given to installing the two additional units at Canal Station.

In any event, President T. B. Wilson announced on Feb. 10 that a new station would be built on a new 50 acre plant site, just outside the southwestern city limits near the mouth of Paddys Run. Both space and circulating water conditions are favorable for unlimited expansion while a high solid river bank makes it possible to literally locate the station "on a hill." This provides adequate flood protection for river level fluctuations of over 80 ft. with a low superstructure cost. This construction is a departure from past power plant practice aimed at reducing circulating

water pumping heads to a minimum, but the savings in plant costs more than compensate for the extra pumping charges. Ground was broken early in March and operation is scheduled for the month of July, 1942.

The total cost, including the plant site and substation, will approximate $6,000,000. This is somewhat more than another extension to Canal Station would have cost, but the new site offers, among other things, the advantage of almost unlimited expansion. Provision for future expansion, principally in connection with coal handling and storage facilities, switchyard and substation also added considerably to the first cost, over and above the minimum requirements for the initial section. Again the sale of high-pressure steam gives a relatively high boiler feed make-up, with a proportionately higher investment in water treating facilities than would have been needed for straight power generation, and this, with other incidentals increased the investment somewhat.

Original Design for Straight Power Generation

In this connection it must be remembered that the station equipment was purchased early for straight power generation, long before the sale of high-pressure steam was considered. It was designed as a modern, low heat rate, low cost station, with two "single-gut" units. The boilers, of a type already in service, were cut close to throttle requirements with a minimum of excess capacity. A straight regenerative cycle was used with the turbines bled at four points for three closed and one deaerating heater. All auxiliaries were motor driven for the proximity of other stations with multiple tie lines made a power failure highly improbable. Two boiler feed pumps (all Ingersoll-Rand), one for 60 and the other for 100 per cent normal requirements were provided for each unit with one 100 per cent pump as a spare for either boiler.

The sale of high-pressure steam will increase the boiler heat input about 20 per cent above the expected requirements at full generator load. The simple solution of increasing the boiler capacity was impossible so a number of station changes were necessary to supply the additional steam with the minimum reduction in electric capacity and so as to allow for heat balance control under different conditions of operation.

Steam sold will be proportioned between the two boilers as operating conditions dictate. Treated make-up after being heated in a separate make-up heater will be split and introduced in the two deaerating heaters in proportion to the steam withdrawn from each unit system. Continuous blowdown from each unit will also be proportioned to the steam withdrawn, with provision for the minimum recovery of heat and water through a series of flash tanks. Blowdown, normally of little consequence, will in this case be a considerable item, in order to hold the boiler water concentration within allowable limits with treated water and high make-up.

Steam for the make-up heater will be provided by the exhaust of single stage Terry turbines. To provide for this, the larger boiler feed pump for each boiler was converted to dual drive. The turbine will be governed automatically so as to supply the steam needed by the heater.

Fig. 3-A. (Below) A distinguishing feature of the station is the separate screen and pump house, as tall as a 14 story building, housing four of the longest travelling screens yet built and four two stage vertical circulating pumps. The pump casings are split near the bottom so the pumps can be pulled for inspection and maintenance without pu ling the entire assembly. The design makes provision for a possible third boiler should the sale of industrial steam increase more than anticipated

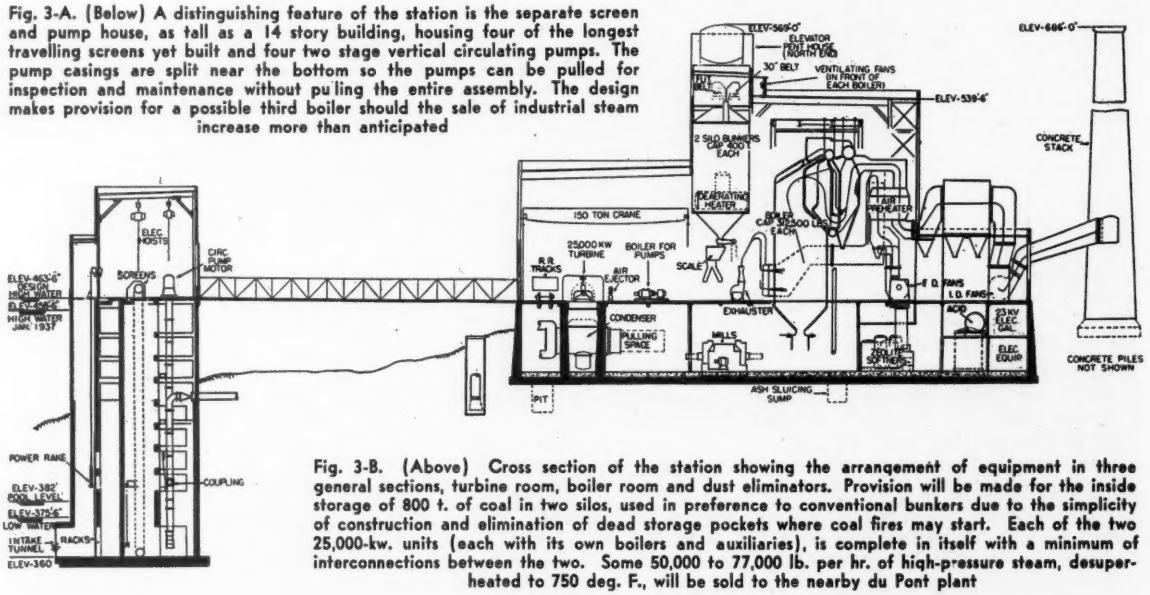


Fig. 3-B. (Above) Cross section of the station showing the arrangement of equipment in three general sections, turbine room, boiler room and dust eliminators. Provision will be made for the inside storage of 800 t. of coal in two silos, used in preference to conventional bunkers due to the simplicity of construction and elimination of dead storage pockets where coal fires may start. Each of the two 25,000-kw. units (each with its own boilers and auxiliaries), is complete in itself with a minimum of interconnections between the two. Some 50,000 to 77,000 lb. per hr. of high-pressure steam, desuperheated to 750 deg. F., will be sold to the nearby du Pont plant

The plant site, only partially shown by Fig. 2, is somewhat irregular in shape. Switchyard and substation are directly east of the main building on the crest of the hill. The coal storage area is directly north of the switchyard, also on high ground and where the irregular area can be utilized to the fullest extent. Two spur tracks serve the area, one leading into the north end of the turbine room, the other over the track hoppers, down past the substation. The third track next to the river is outside of the property line and leads down to the river for unloading barges.

Third Boiler Possible

The initial section will consist of two 650 lb., 900 deg. F., 25,000-kw. single boiler-single turbine units with a minimum of interconnection. There is a possibility that the sale of high-pressure steam will increase to the point where a third

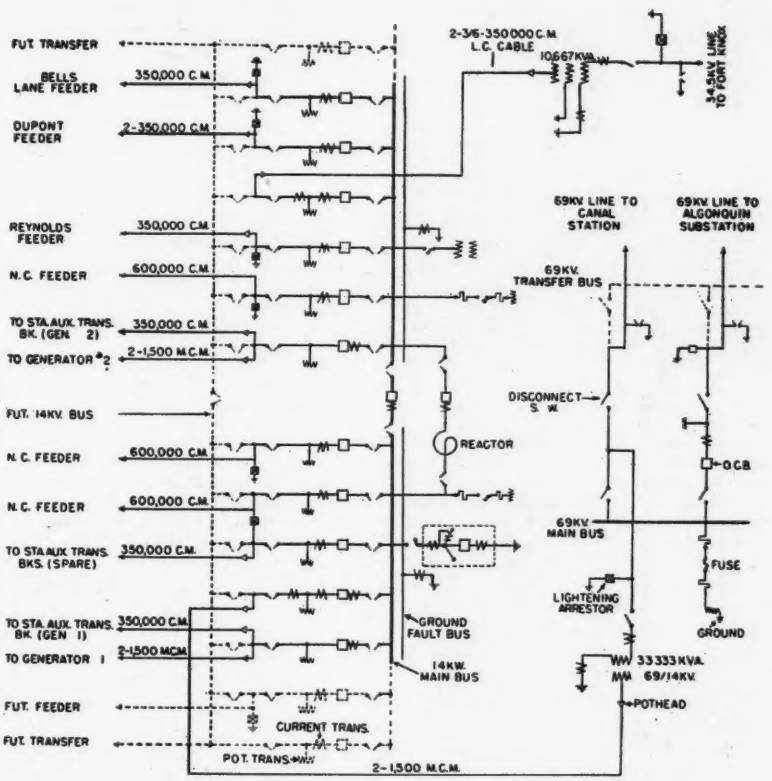


Fig. 4. (Right) Single line diagram of the initial installation of the 69 and 14-kv. substation. The 14-kv. transfer bus shown dotted will probably be installed next year. The initial arrangement provides for two 69-kv. and one 34.5-kv. outgoing line, generating units No. 1 and No. 2, several feeders, two spare feeders, the spare auxiliary bank, and two future transfer sections

boiler unit is advisable. Space has not been provided for this in the present building, but the design is such that it can be accommodated, economically, in a 31 ft. jog between the boiler and turbine rooms. Future extensions will probably utilize larger machines and the tentative ultimate capacity of 300,000-kw. is based on the use of 50,000-kw. units.

Boiler Feed Pumps Adjacent to Turbine

No curtain wall is provided. The boilers face the turbine room across a 24 ft. bay devoted primarily to the evaporators, deaerating heaters, coal silos, scales, feeders and pulverizers. The arrangement of the station is well shown by the cross section, Fig. 3, in which both the simplicity and operating convenience of the design are apparent. Boiler feed pumps and vertical closed heaters are adjacent to the turbines, with the piping concentrated in a pipe gallery just under the main operating floor, but, with sufficient clearance in the basement to allow removal of condenser tubes.

Both forced and induced draft fans are on the main floor, the former taking their suction from a concrete plenum chamber and discharging upward through the air heater and then diagonally downward through ducts to the burner windboxes. Gases leaving the economizer pass through the air heater and precipitators to the induced draft fans. Following the arrangement of the last Canal Station units, the precipitators themselves are installed outdoors on the roof of an extension of the plant which houses the induced draft fans. These discharge to a single reinforced concrete stack isolated from the building proper.

Louisville Type Superheaters

The two Combustion Engineering boilers each have a normal capacity of 250,000 lb. per hr. (312,500 lb. maximum), 675 lb., 900 deg. F. steam per hour. Furnaces are completely water cooled, with bare and finned tubes, and have a volume of 20,310 cu. ft. each. Convection superheaters, screened by a single row of boiler tubes, have a bypass for temperature control and the tubes are particularly wide spaced. This so-called "Louisville" design was developed for the first high-pressure Canal Station unit and has given excellent service there with little or no slagging trouble. One of the new boilers has Diamond, the other Bayer soot blowers and deslaggers. Both units have Bailey feedwater regulators designed to take the full drop across a single pilot operated valve.

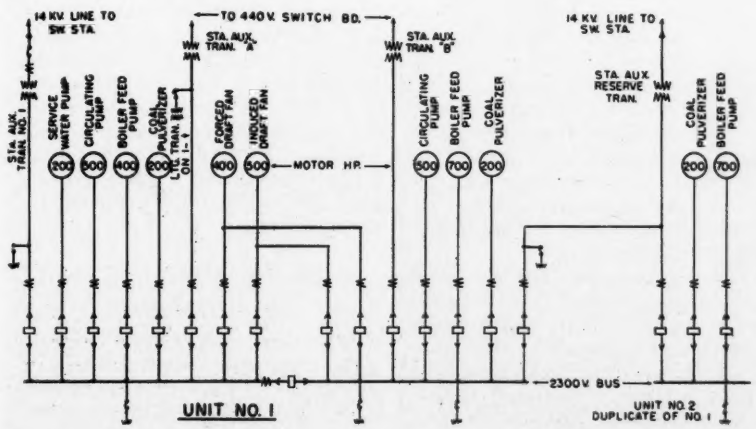


Fig. 5. (Left) Auxiliary power is taken from a 2300 v. bus normally supplied through a transformer bank from the generator leads but with a spare transformer bank connected to the main 14-kv. bus in the switchyard. Each 2300 v. bus is divided by a normally closed circuit breaker with the duplicate auxiliaries split between the two. The single essential auxiliaries, i.e., the forced and induced draft fans, may be fed from either section, so that in case of electrical trouble from 60 to 65 per cent of full load can be carried. The 440 v. switchyard is also supplied from two transformers, one on each bus section. The above diagram is for Unit No. 1 only, No. 2 unit bus is a duplicate of this. A spare transformer bank fed from the 14-kv. bus in the switchyard can supply either No. 1 or No. 2 bus as shown at the right of the above diagram

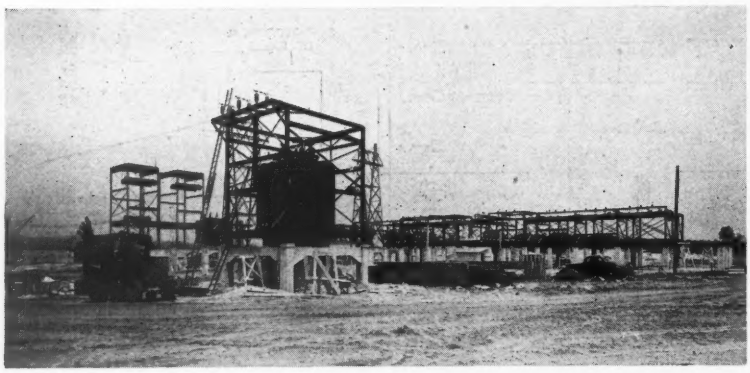


Fig. 6. Substation early in July, with the power plant (boiler drums in place) at the left. The 69/14-kv. transformer in the foreground will supply the district with power until the new station is completed, and, will then feed the outgoing 69-kv. transmission lines circling the city. To provide safe operation at 5 ft. above the 1937 flood level all substation steel work is supported on concrete piers about 10 ft. above ground level. Eventually the area will be filled in up to the top of the concrete. Experience at Canal Station indicates that the boiler ash, mixed with the dust collected from the precipitators, makes excellent fill which packs well and hardens almost like concrete

Each boiler has a 7820 sq. ft. finned economizer, a 49,600 sq. ft. Ljungstrom air heater and a Cottrell precipitator. One Sturtevant forced and one induced draft fan per boiler are provided, each motor driven through an Electric Machinery variable speed magnetic coupling. The capacity of the forced draft fans at a normal load speed of 826 r.p.m. is 82,000 cu. ft. of 70 deg. F. air at 7.95 in. of water; the induced draft fans at 820 r.p.m., 128,000 cu. ft. of 330 deg. F. gas at 8.7 in. of water. Both boilers will be controlled automatically by Bailey combustion control. Each boiler is fired by two Foster Wheeler 19,000 lb. per hr., (coal grindability 51 per cent A.S.T.M.) double ended mills, each mill supplying two burners.

Turbo-generators are Westinghouse, 3600 r.p.m., 14,000 v. hydrogen cooled units rated at 25,000-kw. each at 0.7 p.f., with 650 lb., 900 deg. F. steam and 28.5 in. of vacuum. Turbines discharge to 28,000 sq. ft. Ross two pass condensers, each designed for a normal flow of 30,800 g.p.m. of circulating water.

Circulating Water System

Perhaps the most distinctive feature of the station is the condenser circulating system incorporating a separate screen and pump house with vertical high-speed deepwell pumps in place of the conventional slow-speed horizontal units.

Locating the station high on the river bank eliminated expensive substructure costs with a condenser pit nearly to low water level, but increased the pumping head materially. In the conventional design with a sealed discharge the pumping head will be some 12 to 15 ft., due entirely to friction. At Paddys Run, in addition to the friction head, there will be an additional static head equal to the distance between the discharge weir at about Elev. 323 ft. 6 in. and the river level. Duration curves of the river level indicate that the pumping head will be 57 ft. or less about 50 per cent of the time. A large portion of this extra head is potentially recoverable, within the efficiency limits of a hydraulic turbine. Consideration was given to this recovery but was finally abandoned as uneconomical.

The screen house itself is some 144 ft. high, half of which is underground, and extends down to 15 ft. below low water. It is connected to the river channel by a concrete tunnel provided with trash racks and a vertical power rake as shown by Fig. 3. The 110 ft. Chain Belt travelling screens are thought to be the longest ever built.

Sluice gates are also provided so that the sump can be unwatered in an emergency. However, the casing is split with a special shaft coupling provided some 15 ft. above the pump so that the pump itself can be uncoupled and hoisted to the surface for inspection and repair without unwatering the sump or pulling the entire length of casing and shaft.

The pumps are Ingersoll-Rand two stage deepwell centrifugals, driven by 900 r.p.m. synchronous motors and designed to discharge 18,000 g.p.m. each against a total dynamic head of 80 ft. The characteristic is such that the condensers do not need to be primed when starting up and before the water side syphon is established. Two pumps are provided for each condenser. Each pump is piped separately to the plant and the two lines join just before entering the water box. The two service water pumps for the plant also take their suction from the circulating pump discharge lines.

Coal Handling

Western Kentucky coal (Seams No. 9 and No. 10), averaging about 11,300 B.t.u., will be burned and will arrive by rail. The coal handling facilities have been designed to handle 3500 t. in 7 hr. although belt conveyors of only half this capacity will be installed initially. The track hopper, two tracks wide and two cars long will take care of four cars at once. From the track hopper, pan feeders will discharge to a collecting belt, equipped with a magnetic pulley. The collecting belt in turn discharges, either to an elevator for storage, or, through a crusher (or bypass) to a combination of belt conveyors leading to the plant.

As shown by Fig. 2, the first conveyor flight leads up from the crusher house to a right angle turn and discharges to the second flight which runs over the coal silos. From the initial pile, coal will be stored by a bulldozer and carryall. It will be reclaimed to the track hopper in the same way. The bulldozer and carryall have been in constant service throughout the construction period in grading the plant site. For the coal, two bulldozers (one International and one Caterpillar Tractor - La Plant - Choate) and one carryall (Bucyrus-Erie) will be used.

In the plant itself silos will be used instead of the conventional coal bunkers primarily because of lower first cost, ease in dustproofing, and the elimination of dead storage susceptible to spontaneous combustion. A total storage capacity of 800 t. will be provided in two 400 t. silos. From the silos, coal will feed by gravity, through Richardson coal scales (2 per boiler) and feeders to the pulverizers in the basement.

Substation, Switchyard and Auxiliary Power

All electrical control is centralized in a separate control house at one corner of the switchyard. The initial switchyard and substation

is simple, but both are designed so that they can be expanded as needed. As shown by Fig. 4, a single 69-kv. bus is tied in with the 69-kv. transmission system at two points, with one line to Canal Station and the other to Algonquin and Seminole Substations. The bus is also tied in with the main 14-kv. bus through a 33,333 kv-a. 3-phase transformer. A 14-kv. transfer bus, shown dotted on Fig. 4, will probably be added soon after the station goes into operation.

The main 14-kv. bus, grounded through a zig-zag transformer, is in two sections with a reactor tie between. The substation steel is insulated from ground and relays are installed to clear a bus section in the event of a ground phase fault on the bus. Generator leads are tied directly to the buses and provision is made for: seven 14-kv. feeders; a spare auxiliary transformer bank; and, through a 10,067 kv-a. transformer, a new 34.5-kv. line to Fort Knox to take care of the rapidly increasing load there.

Auxiliary motors of 200-hp. and over, operate at 2300 v. with the power supply normally taken direct from the generator leads through a 3750 kv-a. transformer. A spare transformer of the same size, but connected directly to the main 14-kv. bus may be used to supply either Unit No. 1 or No. 2, as shown at the right of the auxiliary wiring diagram, Fig. 5. The arrangement for Unit No. 2 is a duplicate of No. 1 as shown by the drawing.

For each unit the 2300 v. bus is in two sections, separated by a circuit breaker. Duplicate auxiliaries such as coal pulverizers, boiler feed pumps and circulating water pumps are split so that one is carried on each bus section. Single essential auxiliaries (the forced and induced draft fans) may be operated from either section so that from 60 to 65 per cent load can be carried with one section of the bus dead. The 440 v. switchboards are fed from duplicate 2300/440 v. transformers, one on each section of the bus as shown.

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[3]LOUISVILLE is located at the Falls of the Ohio, which due to their strategic importance on one of the continent's main waterways, have played an important part in American history since early Indian days. At about the time the Virginia Company (1603) was being organized in England to colonize America, the Iroquois or Six Nations won a decisive battle at the Falls, and established title to the territory from the Tennessee River north to the Great Lakes and from the Allegheny Mountains west to the Mississippi River, thus including the entire area later known as the Northwest Territory.

This shadowy and questionable title gained recognition in Europe, was one of the major factors contributing to a century of savage Frontier warfare and nearly blocked ratification of the Articles of Confederation without which the United States as a nation would have ceased to exist.

France lay claim to the territory as a result of the explorations of La Salle and Marquette and this claim was further substantiated by the voyage of Bienville down the Allegheny and Ohio Rivers in 1749.

English claims were less direct and were based largely on the Iroquois title. These Indians, always antagonistic toward the French, were recognized as English subjects by the Treaty of Utrecht signed in 1713. The territory in question was later ceded to the State of New York. Although beaten in Queen Anne's War, the French continued exploration, colonization and missionary work until 1763 when the Treaty of Paris concluded the French and Indian wars and France renounced all title to American territory.

For services in the French and Indian Wars, Dr. John Connolly in 1773 was given a grant of 2000 acres about the Falls by Lord Dunmore, the provincial governor of Virginia. Of this 1000 acres was sold to Col. J. Campbell. The two partners planned to start a British settlement and the area around the Falls was surveyed with this in mind by Capt. Thomas Bullett.

The Revolutionary War put a temporary end to this however. Dr. Connolly was put in jail because of his Tory leanings and Col. Campbell was captured by Indians on his way to Fort Pitt.

George Rogers Clark, commissioned by the State of Virginia to capture the Northwest Territory from the British, floated down the Ohio in 1778 with about 180 recruits and a number of settlers (probably 50 people in 20 families) who had been thrust upon him by circumstances. He established a base on Corn Island, above the Falls and not far from the present Canal Street Station. The island gave him a chance to rest and whip his raw recruits into shape without encouraging desertion; it enabled him to rid his expedition of the settlers without leaving them at the mercy of the Indians; it gave him a permanent base to fall back on if necessary, large enough to resist Indian attacks while he was away and much closer to his field of operation than Fort Pitt; an finally, it was an ideal spot for a settlement, establishing more firmly the claim of the United States (or more specifically the State of Virginia) to the territory.

After capturing Fort Kaskaskia, Capt. Clark returned and ordered the construction of a fort on the Kentucky mainland. This was the start of Beargrass Settlement. In the spring of 1779 John Corbly surveyed a townsite and made a map with one main and 12 cross streets. The Virginia legislature promptly confiscated 1000 acres from the Tory Connolly, and appropriated it for a townsite. Thus the town of Louisville came into existence, named in honor of Louis XVI of France in recognition of his help during the Revolutionary War. By 1828 it had a charter and a mayor replaced the former governing body of 9 trustees.

Following the Revolutionary War six states laid claim to some portion of the territory west of the Alleghenies: Massachusetts, Connecticut, New York, Virginia, North Carolina and South Carolina. Civil war threatened over the formation of new states in the area west of the Carolinas. This, however, was more or less of a local nature and lacked the national political significance of the claims of New York and Virginia.

The New York claim was based largely on the territories ceded to the state by the Iroquois and the Virginia claim was based on royal charter and conquest by George Rogers Clark. Ratification of the Articles of Confederation was deadlocked over the issue. States with land claims wanted the issue settled before joining the Union while states without claims felt that they might in the future be dominated by the larger states.

In the interest of national unity New York gave up her claims in 1781 and Virginia in 1784. Other states renounced their titles. While the Articles were ratified by the necessary majority before the action of New York, settlement of the land claims did much to restore mutual understanding and probably postponed action on the right to secede until the Civil War. Out of part of the territory renounced by Virginia the State of Kentucky was created and admitted to the Union in 1790 as the 15th state.

After the Louisiana Purchase opened up the Mississippi River traffic on the Ohio increased tremendously. The rapids or falls offered no difficulty during high water, but interrupted traffic during low water. The town and island of Shipping Port at the falls came into being as a transfer point for the boats coming up from New Orleans and down from Pittsburgh. In 1830 the 2 mi. Louisville and Portland Canal was opened on the Kentucky side of the river from Louisville to Portland, a village long since incorporated into Louisville proper. The falls were first utilized for power in 1802 when Louis Tarascon built a water driven grist mill at Shipping Port.

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[4]THE OTHER two companies were the Duquesne Light Co. of Pittsburgh and the San Diego Consolidated Gas & Elec. Co. of California. In accordance with the ruling of the S.E.C. the latter company has since been sold and is no longer a unit of the Standard Gas & Elec. System.

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[5]DU PONT'S Neoprene is one of the first successful synthetic rubbers and has been in commercial production since 1932. The original capacity of 250 lb. a mo. was gradually increased to 13,440,000 lb. per yr. by June, 1941. An addition to the Deepwater, N. J., plant will soon bring the production to 20,160,000 lb. By the fall of 1942 the Louisville plant will be in production with an additional capacity of 23,400,000 lb. annually. At present the output is being used exclusively for defense purposes, but it is believed that the Louisville plant will meet the defense requirements and supply at least a portion of commercial needs. As defense requirements slack off it is expected that commercial needs will absorb the surplus and utilize full capacity.

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[6]KOROSEAL, a new synthetic product of The B. F. Goodrich Co. will not support flame, is unharmed by acids and before the Army and Navy requisitioned it all for defense needs was rapidly making a place for itself in waterproofing cloth, raincoats, shower curtains, umbrellas and a wide variety of other domestic and industrial uses. It may be used as a thin transparent coating on other things or as a transparent plastic. It does not get soft or stick, crack or discolor with age.

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[7]BOTH Neoprene and Koroseal belong to a group of materials which range from the so-called synthetic rubber to the plastics and for which coal, limestone, salt, petroleum and sulfur are the basic raw materials. In this case both Neoprene and Koroseal will be made from acetylene and hydrochloric acid and the processes are very similar.

Calcium carbide treated with water produces acetylene and slaked lime. Carbide itself was discovered by accident in 1894 while fusing lime and coal tar in an electric furnace in an endeavor to produce metallic calcium. The process is still fundamentally the same although the electric furnaces used today are much larger and draw 5000-kw. In addition to its use in these two new plants, carbide and acetylene are today basic industrial materials and the Carbide plant output, beyond the needs of the du Pont and Goodrich plants, will be absorbed in regular commercial channels. Of these welding and cutting is an important one for acetylene burned with pure oxygen produces the hottest flame known, 6300 deg. F.

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[8]THIS is one of four factories throughout the United States which will manufacture, by a process using crude oil, the synthetic rubber products Ameripole and Hi-Car, to be used in automobile tires and other articles. Initially, the new plant will produce 23,000,000 lb. annually of the synthetic product and will utilize 1,000 kw. Later it will be expanded to five times this capacity and require 5,000 kw. The plant will be constructed adjoining the Goodrich Company's Koroseal plant on a 21 a. tract and is meant to remain permanently as a peacetime industry. It is to be operated and constructed, under lease agreement with the Defense Plant Corp., by the Hydro-Chemical & Rubber Co., a subsidiary of the B. F. Goodrich Co.

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[9]PRIOR to the completion of the first 25,000-kw. unit in Canal Street Station, the company's generating capacity was 194,820-kw. Of this 92,500-kw. in 225 lb. equipment was in Waterside Station; 12,000-kw. in 185 lb. equipment at Canal Street; and 80,320-kw. in hydro at Ohio Falls Station.

In addition to this generating capacity the company has a 138-kv. tie line with the Cincinnati District; a 66-kv. interconnection with the Public Service Co. of Indiana; two 66-kv. lines with the Dix Dam of the Kentucky Utilities. Another 66-kv. line to interconnect with a new steam plant of the Kentucky Utilities is now under construction.

Why 2 Single-Phase Wattmeters

By ALLEN KELLER
Turbine Engineering Department
General Electric Co.
Lynn, Massachusetts

Direct current is simple. As Li'l Abner would say, any fool can plainly see that. But alternating current, that's something else again; that's complicated and even good electrical engineers go nuts trying to understand phase angles and power factor. All this is unfortunate because we all use lots of this a.c. stuff and if nothing else we would at least feel better if we knew something about it. But cheer up—from now on, things are going to be different. Our old friend Allen Keller, of Force, Weight, Mass and Acceleration fame* has come to the rescue and in this article disposes of all alternating current difficulties by simply assuming that in at any particular instant any alternating current is a direct current. If this sounds silly at first, just think about it a little while and you will see that it is true. However, if it still sounds silly, read what Mr. Keller has to say about the matter; he explains it much better than we can

IN STEAM TURBINE-GENERATOR test work, the two wattmeter method of 3-phase power measurement is frequently used by operators as well as manufacturers, and the question often arises as to the accuracy of the two wattmeter method when the power factors, currents, and voltages of the three phases are not equal. This question is frequently put to men who are not electrical engineers by men who are not electrical engineers and the result is usually a scramble for the handiest text book or other authority on electrical engineering problems.

Here is a logical proof of the accuracy of the two wattmeter method which does not require any equations other than the power equation for a simple direct current circuit.[1] The proof given is not original as far as electrical engineering literature is concerned and is covered in more general form in many text books as Blondel's theorem. It does, however, give a clear understanding of the two wattmeter method in a form with which most engineers seem to be wholly unfamiliar.

*January 1941 issue, pp. 88-92.

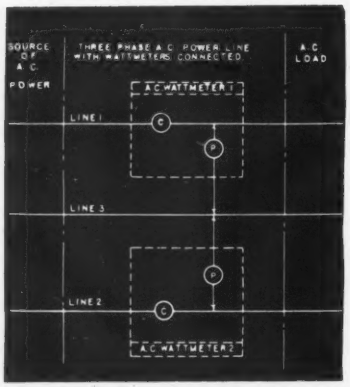

Fig. 1. A two element single-phase wattmeter hook-up for the measurement of power in a 3-phase a.c. circuit

Just what is meant by the two single-phase wattmeter method of 3-phase alternating current power measurement? Figure 1 illustrates the circuit and the hook-up of the instruments. The current elements of the two wattmeters are placed in any two lines of the 3-phase circuit. The potential element of each instrument has one lead connected to the same power line that contains the current element of the same instrument. The other potential lead of each instrument is connected to the third power line which has no current element.

It may also be well to define an alternating current or a.c. circuit. For our purpose, it will be sufficient to say that an alternating current circuit is one in which the magnitude of both the voltage and current are continually changing and in which the direction of the voltage drop and the current flow reverse themselves twice each cycle. Most power circuits in the United States are 60 cycles per sec. which means that the electric current reverses its direction of flow 120 times each second. At any particular instant, however, the circuit will be operating at a particular point in the cycle with a definite current flowing in each wire of the system and with a definite voltage drop between any two particular wires. It may then be said that an a.c. circuit consists of a continually changing d.c. circuit. It is true that in an ordinary 60 cycle a.c. circuit the instantaneous current and instantaneous voltage are both continually changing according to definite mathematical laws which are well known. It is immaterial to the present discussion, however, what those laws are and the statement still stands that, in its broadest sense, an a.c. circuit consists of a continually changing d.c. circuit.

Viewed from this concept, the accuracy of any hook-up for measuring a.c. power may be proved by establishing two points:

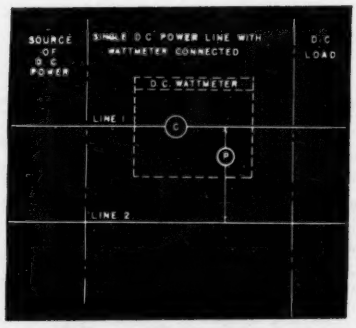

Fig. 2. The conventional wattmeter hook-up for measuring the power of a single direct current circuit

1. That the instrument hook-up is such that at each and every instant, i.e., at every point in the cycle, the voltages and currents impressed on the instruments are an indication of the total instantaneous "d.c." power being transmitted.

Can Measure 3-Phase Power

2. That the a.c. instruments are designed so as to indicate the proper average value for the continually varying "d.c." power being impressed upon them.

In other words, a wattmeter capable of averaging a rapidly changing rate of instantaneous power transmission cannot fail to give the proper reading if the hook-up is such as to impress the instantaneous power values on the instrument.

The second of these two points concerning the ability of a.c. wattmeters to properly average the instantaneous power of a circuit, will not be proved in this article; its proof would involve a consideration of the design of wattmeters which is outside the scope of the present discussion. Suffice it to say that present day a.c. wattmeters do meet this requirement within the stated accuracy of the instrument which, after all, is entirely reasonable. The function of an a.c. wattmeter is to indicate the proper average value for the power of an alternating current circuit whose instantaneous current and voltage are continuously changing; it is designed to do just this specific job.

This leaves, then, the establishment of point 1 as the primary object of this article, i.e., the establishment of the fact that two wattmeters may be hooked-up in a 3-phase circuit so that at each and every instant the total instantaneous power of all three phases is impressed on the two instruments.

As the name implies a 3-phase circuit is composed of three single-phase circuits and the power of each phase must be taken into account when determining the total power of the system. Of course, the three single phases are usually mutually interconnected, but this fact does not detract from our right to consider the 3-phase circuit as made up of three, individual, single-phase circuits. It is proper, then, that before considering the measurement of power in 3-phase circuits we consider a number of hook-ups by which the power of a single-phase circuit might be measured. Also, it may simplify our thinking somewhat to first consider a d.c. circuit rather than an a.c. one.

The Measurement of Single-Phase Power

The usual method of measuring d.c. power with a wattmeter is indicated in Fig. 2. A wattmeter has its current element connected in one line of the circuit and its potential element connected across the two lines. The current element may be placed in either line. The total power of the circuit is the product of the current and the potential drop,

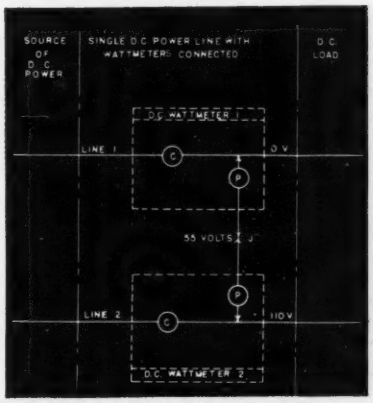

Fig. 3. A "trick" wattmeter hook-up for measuring the power of a single direct current circuit

which is indicated directly by the wattmeter.

Figure 3 indicates an equally accurate but more complicated instrument hook-up for measuring the power of a single d.c. circuit. Two wattmeters are employed with one current element in each line. This means that the current is being metered twice. On the other hand, the potential elements of the two wattmeters are connected in series across the lines, which means that the total potential drop of the circuit will be divided between the two instruments. The percentage of the total voltage drop which will be taken by each of the two instruments will depend on the relative electrical characteristics of the instruments themselves, but, as we shall see, the manner in which the total line voltage drop is divided between the instruments is immaterial to the accuracy of the total power measurement. With two identical wattmeters each instrument would have half the line voltage drop impressed on its potential element. Thus if the circuit were 110 v., d.c., with zero taken as the potential of one line and 110 v. as the potential of the other, the potential at point "J", the junction point of the two wattmeter potential leads, would be 55 v. Then each wattmeter would read the power corresponding to the total line current multiplied by 55 v. Each instrument would therefore indicate half the total power of the circuit, and the two wattmeter readings must be added to get the total power of the d.c. circuit.

On the other hand, the junction point of the two wattmeter potential leads, point "J", could just as well be connected to a third line which is part of another d.c. circuit. Figure 4 illustrates this hook-up. If this extraneous d.c. line attached to junction "J" had a potential of 55 v., then this case would cause the instruments to indicate exactly the same values as in Fig. 3 and each wattmeter would indicate half the total power. But suppose the voltage of the third line attached to "J" were not 55 v.; suppose it were 330 v. What would happen then? Wattmeter 1 would indicate the power corresponding to the total line current multiplied by 330 v. or three times the line voltage drop. Its power indication would be three times the correct power of the d.c. circuit. Likewise, wattmeter 2 would be working with 330 minus 110 v., or 220 v., potential drop and would indicate twice the correct power of the circuit. The true power of the d.c. circuit would then be the difference between the readings of meter 1 and meter 2.

It would appear, then, that the junction point of the two, free, wattmeter potential leads might be attached to an extraneous line with any voltage whatsoever, the true power in any case being either the sum or the difference of the power readings of the two wattmeters. This fact gives rise to a very important conclusion as far as the present discussion is concerned.

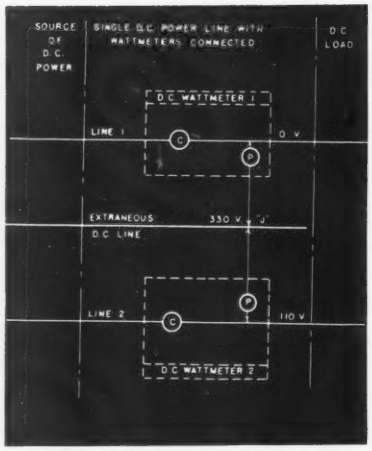

Fig. 4. Another "trick" wattmeter hook-up for measuring the power of a single direct current circuit

If the two free wattmeter potential leads may be connected to a line of any voltage whatever without impairing the accuracy of the total power indication, then with suitable instruments which can accurately follow a changing potential drop and indicate the proper average power it should be entirely satisfactory to connect the two free potential leads to a line of rapidly varying voltage such as an a.c. line.

Thus, with suitable instruments the power of a 110 v. d.c. circuit might be measured using two wattmeters as in Fig. 4 with the free potential leads connected to one line of a 2300 v. 3-phase a.c. circuit.

Figure 5 illustrates the same circuit as Fig. 4 except that the current is now a.c. instead of d.c. The instantaneous power being transmitted by an a.c. circuit is instantaneous volts times instantaneous amperes just as with a d.c. circuit. If the current is flowing in the same direction as the impressed voltage drop, the power is positive; if flowing in an opposite direction, it is negative. No correction for power factor need be introduced. The concept of power factor comes into a.c. circuit analysis only when one ceases to work with instantaneous values of current and voltage and starts working with average values for one or more cycles. An a.c. wattmeter works with instantaneous values of current and voltage and averages the product. It therefore indicates true average power without the necessity for a power factor correction to its reading.

When instantaneous values are considered, a current can never be "out of phase" with the impressed voltage; it can only be positive or negative, i.e., flowing in the same or opposite direction as the instantaneous voltage drop. The term "out of phase" comes into being when considering how the voltage and current vary throughout a complete cycle and indicates that the maximum current occurs at a different time (on a clock indicating split seconds) than the maximum voltage. In this discussion we are considering instantaneous values of current and voltage; therefore the expressions "in phase" and "out of phase" are meaningless.[2]

At this point the reader may wonder, "Why consider all these 'trick' hook-ups for measuring the power of a single circuit using two instruments when a much simpler hook-up using only one instrument will give the proper answer? The reason is that in a 3-phase a.c. power system, when the two wattmeter method is used, the power of one phase is measured by the hook-up shown in Fig. 5.

The Measurement of Three-Phase Power

Let us now consider the measurement of power in a 3-phase a.c. circuit as illustrated in Fig. 6. As an aid to a visualization of what is actually taking place at any instant the various individual phase loads are indicated. The individual single-phase loads might all be the result of a single 3-phase electric machine, such as a polyphase motor, but the instantaneous 3-phase load, however complicated, may be broken down into three independent single-phase loads as illustrated.

Of course, in an a.c. circuit the voltages and currents are continuously changing. At any particular instant, however, there will be definite values for the current in and the voltage of each line of a 3-phase circuit. To prove the accuracy of the two wattmeter method, it will be necessary to make sure that the two wattmeters properly distinguish between positive and negative power, i.e., current flowing in the same direction as the voltage drop and in the opposite direction. In order to have specific values of algebraic signs with which to deal in this discussion it has been assumed in Fig. 6 that at the specific instant under consideration (at a particular point in the cycle) line 1 has the highest voltage, line 2 has the lowest voltage, and line 3 has an intermediate voltage. It is also assumed that at the particular instant under consideration the instantaneous power of each circuit is positive, the current in each phase of the load is flowing in the same direction as the voltage drop. Current is therefore flowing from line 1 to line 3 and also from line 1 to line 2. The current in line 1 is therefore the sum of these two phase currents. Similarly, the current in line 2 is the sum of the instantaneous currents of phase 1-2 and phase 3-2. The current of line 3 may be in either direction depending on whether the current of phase 1-3 is greater or less than the current of phase 3-2, but since no wattmeter current element is inserted in this line, we are not interested in the magnitude or direction of this current.

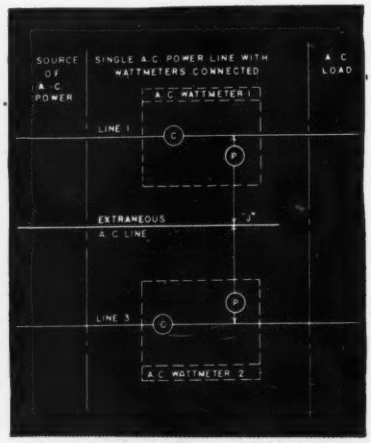

Fig. 5. Same wattmeter hook-up as for Fig. 4 except for a single-phase alternating current circuit

Any other assumptions could just as well have been made concerning the relative values of the instantaneous voltages of the three lines and the directions of current flow relative to the voltage drops. The accuracy of the two wattmeter method can be proved for any combination of voltage drops and currents and the pattern formed by these variables will, in fact, change several times during each cycle.

First of all, let us see how the power of phase 1-3 is measured. This power is measured on wattmeter number 1 by the instrument hook-up illustrated in Fig. 2 except, of course, that we are now dealing with an a.c. circuit with a.c. instruments instead of a d.c. circuit with d.c. instruments. The instantaneous current of phase 1-3 is flowing through line 1 as part of the total instantaneous current in that line. The voltage drop of

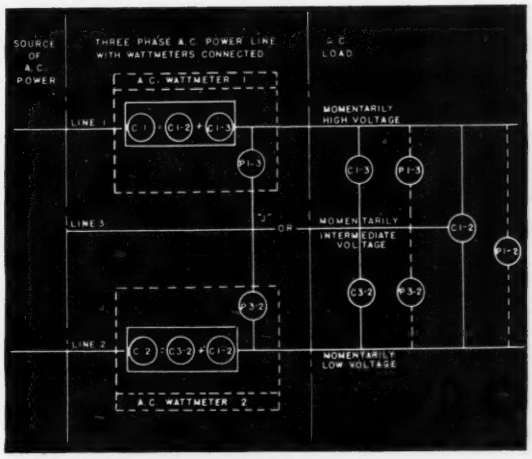

Fig. 6. A two single-phase wattmeter hook-up for the measurement of power in a 3-phase alternating current circuit with the three single-phase loads shown

the phase under consideration, phase 1-3, is impressed directly on this wattmeter; therefore it will be impressed with the instantaneous power of phase 1-3.

In like manner the instantaneous power of phase 3-2 will be impressed on wattmeter number 2.

Next consider the instantaneous power of phase 1-2. This instantaneous power will be impressed partly on wattmeter 1 and partly on wattmeter 2 by the hook-up shown in Fig. 5. The current of this phase is flowing through the current elements of both wattmeters, but the total potential drop is split between the two instruments. Furthermore, the current of phase 1-2 goes through each instrument in the same direction the currents of phase 1-3 and 3-2 go through the respective instruments, therefore the instantaneous power of phase 1-2 will be additive on the instruments which is what is desired since it represents positive power.

We conclude, therefore, that the instantaneous power of each phase is properly impressed on the two wattmeters in combination and that if the wattmeters themselves are capable of averaging instantaneous power values, as they are, they cannot fail to give the proper power indication for the 3-phase circuit.

As was mentioned previously, the indications of the two wattmeters may be reasoned out for any combinations of voltage drop and direction of current flow with the same conclusion, namely, that the combined reading of the two instruments represents the correct power. Sometimes the two wattmeter readings must be added, and at other times the difference between the two readings must be taken. There will be times in every 3-phase cycle, even with unity power factor, when one or more phases will contribute current through one or both of the two wattmeters which will be in an opposite direction to that of the potential drop being impressed on the instrument. Such conditions represent negative power as far as the instrument is concerned (remember from Fig. 4 that one meter may indicate negative power even when the power of a single-phase circuit is positive) which will be subtracted in determining the net indication of the instrument. With a balanced 3-phase circuit having equal average current and equal average voltage in each phase, at power factors less than 0.50, one of the two wattmeters will be impressed with more negative power than positive power. This means that the net indication of this instrument must be considered as negative and subtracted from the reading of the other instrument to obtain the true power of the 3-phase circuit. This comes about by the fact that at low power factors phase 1-2 of Fig. 6 impresses more negative power on one of the two wattmeters than the positive power impressed on the same instrument by the other phase measured by that instrument.

We conclude, therefore, that two single phase wattmeters may be connected as shown in Fig. 1 and Fig. 6 to measure the power of a three line, 3-phase alternating current circuit and that, in every case, the true power of the circuit will be represented by either the sum or the difference of the two wattmeter readings. This power indication will be correct without regard to conditions of balance or unbalance in the three circuits and without regard to the wave forms for the currents and voltages of the various circuits.

Does not this viewpoint give a clear picture of what actually happens when the power of a 3-phase a.c. circuit is measured on two single-phase wattmeters? Perhaps the picture set forth in this article should not be considered as superseding the conventional method of analysis of the two wattmeter method involving vector diagrams and the like but rather as an adjunct thereto which should aid materially in obtaining a better insight into what actually happens in an a.c. circuit.

[1] The two single-phase wattmeter method may be inaccurate and should not ordinarily be used where the source of 3-phase power is Y connected and has the neutral grounded. With a grounded neutral currents may be flowing through the ground whose power will not be properly measured by the two wattmeter method. The discussion given in this article assumes that the currents of the 3-phase circuit are flowing only in the three wires of the circuit.

[2] Perhaps a little further discussion of power factor will not come amiss for many readers since most analyses of a.c. circuits are not based on a consideration of instantaneous values and the introduction of power factor is then necessary. For a person steeped (or, for that matter, for a person not steeped) in conventional methods of a.c. circuit analysis it is rather difficult to get away from vector diagrams, power factors, phrases like "in phase" and "out of phase," and the like. The statement that "the instantaneous current cannot be anything other than in phase with the instantaneous voltage drop" may come as a shock.

When an electric current flows out of phase with the impressed voltage drop (as popularly defined) the average current times the average voltage (average here does not mean a straight arithmetical average but rather the root-mean-square value) is not the same as the average of the instantaneous current-voltage product. In other words it is a case of the average of the products not being equal to the product of the averages. True a.c. power is represented by the average of the product of an instantaneous current times an instantaneous voltage which a wattmeter indicates. The concept of power factor is then introduced as a correction to the product of average instantaneous current times average instantaneous voltage in order to get a correct value for the average of the instantaneous products of these two variables.

More Power From Niagara

ADDITIONAL diversion of 5000 cu. ft. per sec. from Niagara River by Niagara Falls Power Co. until Oct. 1, 1942, has been authorized by Federal Power Commission, to develop 64,100-kw. This power will be allocated by the Commission to consumers working on National Defense projects in the Buffalo-Niagara Falls area. Net revenue from this power will be used to reduce net investment, after the authorized diversion period, thus reducing cost to the Government in the event of recapture of the project by the Government.

REFRIGERATING ENGINEER

Part X

In this chapter our developing refrigerating engineer runs into a lot of trouble with his cooling tower. He discovers that such towers cannot be effective when they are used as pigeon roosts—and this one was. So he decides to keep the pigeons away by building a screen around the tower, an obvious solution which, however, did not work out very well

BY GEORGE HOLMAN

STARTING your second week as refrigerating engineer, you get to your plant with a feeling of dismay. A full hard week's work behind you, and the end of hard work nowhere in sight. Two hundred more tubes to clean, besides doing your other chores. And at 16 a day, that will be nearly 2 wk. Oh, yes. That valve in No. 9. Butch says the temperature didn't come down at all last night. You look at the frost beginning to melt off the pipes, and agree with two of his suggestions: that the valve is probably stopped up or that the stem is set up too much.

After backing the stem off to the limit without hearing anything like the gurgling of liquid passing through the orifice, you decide that the valve is clogged with scale. You take it out, clean it thoroughly, and replace it into the system. But it still doesn't work. You take it out again, and again take it apart. While examining the valve a second time you notice something you missed the first. Pressure on the diaphragm reveals the fact that the diaphragm will not respond to your thumb pressure. The remote bulb has lost its charge.

You box the valve for shipment to the maker for recharging of the power assembly and move one of the valves from the ice storage for temporary use in No. 9 cooler. Then you go back to your worry about cleaning those condenser tubes. Two weeks. There ought to be a quicker way.

There is. When you open the toolbox to get the cleaner your eye falls on an old drill shank. The old drill gives you a bright idea. You call up the Pierce Machine Shop and ask to rent a portable electric drill. Why turn that cleaner by hand when electricity is itching to turn it for you?

Cleaning the Tubes

There isn't much room atop the condenser to work with the drill. But by cutting your sections of pipe to half lengths, you find that you can spin the cleaner in the tubes fairly well. Your worst trouble comes when you go to take the cleaner out of a tube after cleaning. On the first tube you back the cleaner up one section, take that section off and chuck the next section in the drill to lift the pipe to the next connection, spinning the whole with the drill. It is a worrisome job, especially when you find that you must use two stillsons to unscrew each connection. And doing work like that 20 ft. from the floor with your head stuck out at right angles to keep from constantly butting the ceiling of the beam.

On the second tube you clean with the drill, the last section of pipe accidentally comes loose from the chuck and the cleaner with seventeen lengths of pipe each length 12 in. long falls through into the drain pan. An accident, but glory be! a good one. By ignoring the water streaming down and climbing into the drain with your stillsons, you find that you can uncouple 6-ft. sections of pipe at a time, and finish dismantling it on the bench.

Within 3 da. you clean the condenser, every one of the 216 tubes. And in the same time you shut down just 23 times to clean the traps in the recirculating water line. Each time the strainers are clogged with a soft cottony down with the cottonwood seeds attached, and some other substances, such as feathers, hardened dung and June bugs. At the end of the cleaning procedure you clean the accumulation of what-not from the drain pan and go outside for a breath of air. Cleaning the condenser has reduced the discharge pressure by a full 15 lb. But the temperature differential between the water entering the condenser and that leaving the condenser has increased 2 deg.

The Water Has B.O.

With the cleaning of the condenser completed, you expect the offensive odor of the water to disappear. It doesn't. Approaching the plant next morning, you notice a dozen of the neighboring pigeons take wing from the cooling tower and circle about. All at once it dawns on you why the water stinks so badly. The pigeons and spatzies, among other birds, are using the tower for a bath. That must cease, even if you have to buy enough shells for your pump shotgun to kill every pigeon in Giles county.

As soon as you check over the machines, you climb to the roof. No wonder the tubes were dirty and the water smelling bad. The drain pan beneath the cooling tower is half full of something besides water. The whole is covered with a luxuriant growth of greenish brown algae, looking something like a Brussels carpet. You dip your hand into the carpet. It falls to pieces. And beneath it is a foul smelling mushy substance consisting mostly of bird dung in which is mixed a few leaves, feathers, the old bones of a long dead pigeon. An awful mess.

Climbing to the top of the tower, you find things there in about the same condition as below. The water distributing trough is almost full of the same substance as is in the drain below. Old scum has dried on the lattice work. Two of the screens through which the water falls have broken down.

You climb back down and get your broom. Starting with the distributing trough atop the tower, you scrub everything, washing the whole tower as you

move downward. Much of the dried scum remains on the screens. You rake off what you can reach through the louvres, and leave the rest, even though you know that the flakes will eventually come down through the condenser and stop up the traps Before tackling the drain pan, you climb down to the machine room for a look around. You get there just in time to shut off the compressors and keep the high-pressure cut-outs from shutting them off.

You look for the cause of the high pressure. Yes, the water supply. You should have noticed that the water coming down through the tower was diminishing in volume. The traps are stopped up. But that isn't the worst of it. The stuff you are cleaning out of the tower has clogged the holes in the condenser strainer plate, and water is streaming down over the outside of the shell. You climb the ladder and reach an arm into the water filled splash ring. The plate is covered with the flaky substance which you swept off the lattice work at the top of the tower. Now you must clean the plate and the trap strainers too.

Yet by quitting time you have the tower as clean as it has been since it was built. But judging from the number of pigeons flying around, it won't stay that way long. You decide to do something about those pigeons, for to your dismay you find that you must now clean the condenser tubes again. You call up a carpenter and tell him to come over the first thing in the morning.

Comes the Carpenter

In the morning the carpenter and his helper appear. "I'm bothered with pigeons, spatzies, bugs and cotton from these cottonwood trees getting into that cooling tower up there on the roof," you inform the carpenter. "The pigeons make the water smell like halitosis. And the feathers, bugs and other filth clogs up the strainers in the recirculating water line. I could take the strainers out; but if I did that, the stuff would settle out in the jackets of the machines, and the cooling water would do no good. I want a frame built around that tower, and fly screen put on it. That will keep everything out, even to these cottonwood seeds drifting around."

While you again clean the condenser—in a much shorter time, however — the carpenters erect a scaffold-like framework around the tower, and cover the top and sides of it with fly screen. You gaze pridefully at the fly screen, with its fine mesh. Not only will you now keep the pigeons and spatzies out of the tower, but also leaves, bugs and the troublesome cottonwood seeds with which the air on some days seems to be filled. You tell the carpenters to send their bill to Frosty Coldfax, and inspect the plant before turning it over to Allen. You are getting the plant in better shape every day, you decide, as you primp a little in getting ready to take June Frost to a movie. That tower is one worry disposed of.

Disposed of? You get to the plant next morning only to find Andy looking troubled. "There is something wrong with the recirculating water system, Abel," he complains. "I had a notion to call you out of bed. Allen told me when I came on shift that he had called you twice, but that you weren't home. He said that the discharge pressure climbed 20 lb. on him within 2 hr. after you left. It seemed like the pump wasn't delivering enough water. He thought it was the traps, and shut down twice to clean the strainers. But all the suction strainer had in it was a few broom straws. Then he thought the pump was air bound, or maybe sucking air through the packing. He tried priming it and repacking it, but neither did any good. When I come on, we climbed up and looked at the temperature of the water coming from the tower. It was 88 deg. And at night with the outside temperature 76."

Andy goes home, leaving you with your headache. You get to figuring that the humidity is pretty high. Having learned from your refrigeration book what a psychrometer is and how to use it, you send to the Aurora for one of those instruments. On slinging it you get a dry bulb reading of 84, and a wet bulb reading of 69. If the water coming from the tower was only within 10 deg. of the wet bulb reading, certainly it would be cool enough.

You try to run for awhile by spilling water from the condenser drain to the sewer, and letting in cooler make-up water from the city mains. But by 10 o'clock you know that you must do something. You step to the telephone and call up the carpenters you had yesterday. In less than a quarter hour they arrive. "What's the job?" the head carpenter asks.

"You know that screen you put around that tower on the roof yesterday?" you remind them. "Well, I want it taken off. Just the screen, not the framework."

The Carpenters Think You're Nuts

The men ask no questions, although they doubtless think of plenty. They climb to the roof and start pulling tacks. When they get the screen off and rolled up, they come back down to the machine room. There the head pressure is back to normal.

"What was wrong with the screen?" one of the carpenters, unable to restrain his curiosity any longer, asks.

"The mesh was too fine," you tell him. "It cut off the circulation of air through the tower. In place of the fly screen, I want the scaffold you built covered with chicken wire about one and one-half mesh. That will keep the pigeons out, as well as other birds as small as a spatzie."

The one and one-half mesh solves the bird and odor problem. For the algae growth you first try boiler compound. But when Allen starts to harvest ice that evening of your first dosage, and water laden with soda-ash comes through the gas desuperheater and begins to spray over the first can in the dump, you realize that it is easily possible for the soda-ash to contaminate the ice you are otherwise taking so much pains to keep pure and wholesome. You open the drain valve and spill the compound laden water to the sewer. Algae or no algae, you will keep that ice as clean as possible.

Next solution for the algae problem that occurs to you is blue vitriol, or copper sulphate, the $CuSO_4$ of the chemists. But when a little undissolved lump of it lying on the angle-iron rim of the condenser drain pan eats out a hole ⅛ in. deep in the iron, you get scared of blue vitriol. If it ate a hole like that in one of the condenser or desuperheater tubes ⅛ in. deep, you would feel as blue as the vitriol is. For the walls of the tubes are only ⅛ in. thick. And behind those tubes is, right at the present moment, ammonia gas under 200 lb. per sq. in. pressure.

At last you resort to chlorinated lime. This effectively controls the algae, but leaves an odor almost as bad as the pigeons did.

Having subscribed to the refrigeration journal, you answer an advertisement in it concerning algae control. Within a week you have a substance which, while being far from perfect, does give fair results.

The birds and algae cared for, that leaves leaves, bugs and especially the winged seeds of the cottonwoods. Each time when you notice the differential of the water temperatures to and from the condenser increase, and you know that you've got to shut down and clean out the strainers, you go out and angrily watch the summer snowflakes drift lazily about. You look at the row of trees stretching straight away into the warm south wind. Your hands itch for the feel of an axe handle, while you try to figure out how much time in jail a judge would give you if you sneaked out some night and made the street look like a movie scene of logging operations.

(To be continued)

The MODERN STEAM TURBINE

By C. C. FRANCK
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IN ORDER to completely comprehend the developments leading toward the design of modern steam turbines, it is necessary to study the fundamental trends in the art and their effects on the power plant as a whole. Figure 2 covers this subject as related to condensing units from 1900 to the present day. The sharp reduction in heat consumption in 1922 was a direct result of the adoption of the regenerative cycle. About this same period, the wide spread use of industrial turbines of from 1000 to 7500-kw. firmly entrenched the 3600 r.p.m. type of unit with subsequent decrease in physical size. However, up to 1928, units of 10,000-kw. and above were confined to the 1800 r.p.m. class.

Thermal studies indicated that the use of increased pressure and temperature would result in operating economies, but since materials limited the upper temperatures, it was only possible to utilize the increase in pressure. Steam conditions of 1200 lb. per sq. in. ga. and 750 deg. F.t.t. were accompanied by excessive moisture and erosion in the exhaust blading of complete expansion turbines. To combat this, it was necessary to resort to inter-stage reheating, and boiler and plant layout complications impeded the progress of this development.

Stations using the principle were highly successful and economical as evidenced by the dip in the heat rates at this period. The turbines used in conjunction with the high pressure sections of these plants were the fore-runners of the modern "superposed" turbines.

Metallurgical developments made possible the use of steam temperatures of 925 to 950 deg. F.t.t. and the super-position plants of 1934 to 1936 resulted. The thermal advantage may be observed by following the dotted line on the heat consumption curve of Fig. 2, and the modernization of the 1915-1920 plants was realized by following this procedure.

In addition to the gain from the application of the superposed principle, a further thermal improvement was obtained by fitting steam driven auxiliaries into the heat balance of the combined plants. The use of non-condensing and non-condensing extraction type turbine drives offset the inability to alter the existing low-pressure turbines to supply steam to the feed heating system.

Installation of new condensing capacity for the greater part has developed around steam conditions of 850 lb. per sq. in. ga. and 900 deg. F.t.t. This has been based upon economic considerations, although, in some cases, 1250 lb. and 900 deg. to 925 deg. F. has been justified. It is interesting to note that practically all this development centered around the use of 3600 r.p.m. type units. Superposed units and tandem condensing units of 65,000-kw. are under construction and by various combinations of cylinders, 100,000-kw. units at 3600 r.p.m. are in manufacture and operation.

The metallurgical aspect in the design of modern steam turbines probably holds the center of importance. The creep or growth of metals under elevated temperatures and constant stress was carefully investigated. Limits of projected permanent deformation as a function of temperature and allowable stress, provided the necessary tools to enable the designer to develop adequate structures.

Relaxation of bolting was carefully investigated and suitable materials developed. The development of bolting has been a major problem and materials with high relaxation stress values were in the majority of cases, found lacking in other essential properties.

Higher temperatures have dictated the use of solid forgings for turbine rotors, regardless of the type of turbine used. Also higher temperatures and stresses in rotating parts necessitated the use of alloy steel forgings and while difficulties were encountered, the problems associated with this type of forging have been taken into account.

The majority of the design problems of the turbine engineer

Editor's Note: For further details of turbines and turbine blading see Why Modern Turbines Have Changed by the same author, on page 65 of the October, 1940, issue. The present article is taken from a paper presented before the Mid-west Power Conference.

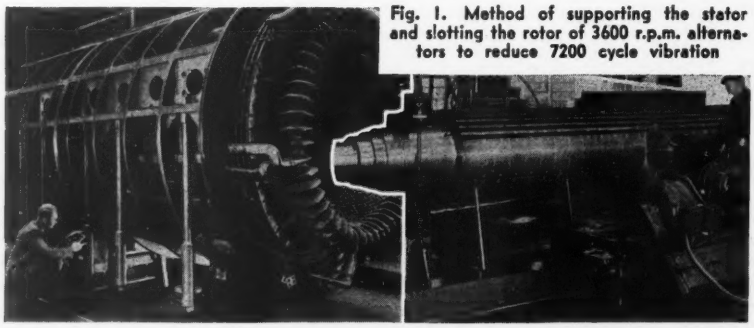

Fig. 1. Method of supporting the stator and slotting the rotor of 3600 r.p.m. alternators to reduce 7200 cycle vibration

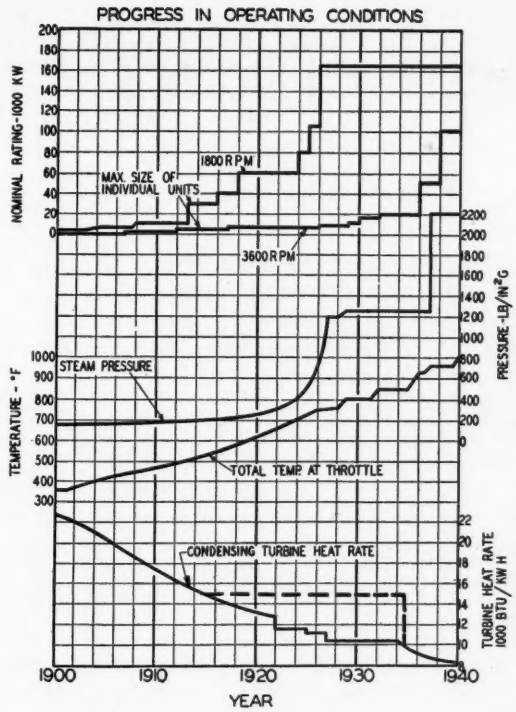

Fig. 2. (Left.) A chart of power station progress for 40 yr. Tracing the growth of turbine size, increase in steam pressure and temperature and decrease in the heat rate

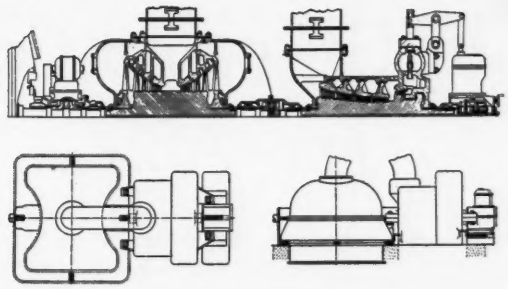

Fig. 3. (Above right.) Bearing supports used to allow free expansion in all directions. A turbine of this type will change ¾ in. in overall length due to expansion

are centered about the ability to predict and properly allow for the effects of differential temperature. For example, an 850 lb., 900 deg. F.t.t., 29 in. vacuum, 50,000-kw. tandem type 3600 r.p.m. condensing unit shown, has an overall change in length of approximately ¾ in. when passing through its normal heating and cooling cycle.

Any attempt to restrict the motion resulting from temperature changes would result in possible internal rubs and rough operation. The skeleton diagram of Fig. 3 shows the method of allowing this expansion to proceed without restraint, yet in a completely controlled manner.

Stability of bearing alinement is mandatory and the secret of smooth operation over wide ranges of load lies wholly in the ability to keep the elevation of individual bearings and bearing pedestals free from subversive temperature differentials encountered within the cylinders. Accomplishment of these principles must make provision for individual bearings and bearing pedestals to support the high and low-pressure spindles. In addition, the transverse members of the foundation support and maintain the alinement of these bearings independent of temperature distribution within the cylinder.

Another point which is given careful consideration, is the influence which the expansion of the main steam lead has on the reactions transmitted to the turbine cylinder. Piping systems, in general, resolve themselves into rather complicated shapes and mathematical solution is very laborious. Systems of this type are studied by scale model tests which provide means with which to determine the resultant forces. Operating experience and mechanical design are more closely related than ever. Recognizing the importance of this aspect of the problem, fruitful results were obtained from well planned field studies during preliminary runs. The outstanding findings of these investigations centered about the differential axial expansion existing between the spindle and cylinder under various conditions of operation.

By charting the differential expansion of various parts of the unit during warming-up, changing load, and shutting down; necessary allowances may be established so that the space to "run around in" can be predetermined. The results of many such investigations indicate the impracticability of predetermining and maintaining axial positions with any degree of accuracy. This is especially true when the parts are at some distance from the thrust bearing or point of mutual connection between the rotating and stationary parts.

As a result, all parts beyond the control stage are designed for radial clearances with all seals arranged on cylindrical surfaces in such a manner as to eliminate the effects of differential axial expansion.

When the newly designed machines of the 1935-1937 period were placed into operation, difficulty was encountered with rusting of the lubricating systems and associated parts. This was not the red rust, but a black magnetic oxide of iron in hard blister form with corrosion pits underneath and the first evidences of this were thought to be foundry sand or filings. Since these machines embraced a new principle of governing necessary to adequately furnish the snap action control required in conjunction with the high pressures, the finger of suspicion was pointed towards this element.

Investigation disclosed the fact that the cause of this disturbance could be traced to the highly refined turbine oils developed several years previous to this time. This process apparently removed a desirable element in the older oils which "wetted" the surface and even when small traces of moisture were present, the phenomena proceeded at a rapid rate. This discovery was concluded with the development of the Kuebler Test for determining the rusting propensity of oil.

When an oil passes this test, the problems associated with rusting have been, in general, eliminated. It is interesting to note that the early rusting problems were cured by vaccinating the new batch of highly refined oil by the addition of a small percentage of old oil. In this manner the necessary wetting properties were established and rusting tendencies eliminated. This problem is now well in hand and the wetting properties may be imparted by the addition of agents or by reprocessing.

(Continued on Page 104)

Units and Conversion Factors For ABSOLUTE VISCOSITY

Even a casual survey of literature in heat transfer, fluid mechanics, hydraulics and related fields reveals that many different combinations of units are employed in this country and abroad for expressing the concept of absolute viscosity. It is often necessary in the solution of engineering problems to transfer from one system of units to another and it is important that the engineer be able to do this accurately and rapidly. Therefore data are presented which will be of help to the practicing engineer confronted with the use of absolute viscosity in the solution of problems

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BEFORE DISCUSSING the subject of units used for expressing absolute viscosity it is important to consider briefly the friction in fluids and the significance of viscosity. Consider for the moment the fluid flow between two parallel flat plates located (d) distance apart, one of which moves relative to the other with a velocity (v). The perpendicular distance from one of the plates to a point in the fluid between the plates is expressed by the symbol (y). The relative motion of the plates is such that the velocity change in the fluid between the plates is linear.

Then the internal friction of the fluid causes a resistance to the motion of the plates which is proportional to the velocity gradient (dv/dy) of the fluid between the plates. A resistance force per unit area or a shear stress is developed which is proportional to the velocity gradient and may be expressed by the following relation:

$$\tau = \mu \frac{dv}{dy} \qquad (1)$$

In this relation (τ) represents the shear stress, (μ) a proportionality factor, and (dv/dy) the velocity

Table IA. Conversion factors for changing absolute viscosity from one set of units to another. To use the table: (1) locate the original units for viscosity in the vertical left hand column; (2) move horizontally until directly under the desired units; and (3) read the conversion factor at the intersection. Multiplying the original viscosity value by this factor converts the viscosity to a new value having the desired new units. In order to clearly distinguish between the system of measurement used in each case, the lb., gm. and kg. values are always indicated by (F) for force units and (M) for mass units. This table is continued on the next page to cover 14 additional units

	CENTIPOISE	POISE	GM(F)SEC/CM^2	GM(F)SEC/M^2	KG(F)SEC/CM^2	KG(F)SEC/M^2	LB(F)SEC/IN^2	LB(F)SEC/FT^2	LB(F)HR/IN^2	LB(F)HR/FT^2
CENTIPOISE	1.0000	1.0000×10^{-2}	1.0197×10^{-3}	1.0197×10^{-1}	1.0197×10^{-6}	1.0197×10^{-4}	1.4504×10^{-7}	2.0886×10^{-5}	4.0289×10^{-11}	5.8016×10^{-9}
POISE	1.0000×10^{2}	1.0000	1.0197×10^{-3}	1.0197×10^{1}	1.0197×10^{-6}	1.0197×10^{-2}	1.4504×10^{-5}	2.0886×10^{-3}	4.0289×10^{-9}	5.8016×10^{-7}
GM(F)SEC/CM^2	9.8067×10^{4}	9.8067×10^{2}	1.0000	1.0000×10^{4}	1.0000×10^{-3}	1.0000×10^{1}	1.4224×10^{-2}	2.0482	3.9510×10^{-8}	5.6895×10^{-4}
GM(F)SEC/M^2	9.8067	9.8067×10^{-2}	1.0000×10^{-4}	1.0000	1.0000×10^{-7}	1.0000×10^{-3}	1.4224×10^{-6}	2.0482×10^{-4}	3.9510×10^{-10}	5.6895×10^{-6}
KG(F)SEC/CM^2	9.8067×10^{7}	9.8067×10^{5}	1.0000×10^{3}	1.0000×10^{7}	1.0000	1.0000×10^{4}	1.4224×10^{1}	2.0482×10^{3}	3.9510×10^{-3}	5.6895×10^{1}
KG(F)SEC/M^2	9.8067×10^{3}	9.8067×10^{1}	1.0000×10^{-1}	1.0000×10^{3}	1.0000×10^{-4}	1.0000	1.4224×10^{-3}	2.0482×10^{-1}	3.9510×10^{-7}	5.6895×10^{-5}
LB(F)SEC/IN^2	6.8947×10^{6}	6.8947×10^{4}	7.0305×10^{1}	7.0305×10^{5}	7.0305×10^{-2}	7.0305×10^{2}	1.0000	1.4400×10^{2}	2.7778×10^{-4}	4.0000×10^{2}
LB(F)SEC/FT^2	4.7880×10^{4}	4.7880×10^{2}	4.8823×10^{-1}	4.8823×10^{3}	4.8823×10^{-4}	4.8823	6.9445×10^{-3}	.10000	1.9290×10^{-6}	2.7778×10^{-4}
LB(F)HR/IN^2	2.4821×10^{10}	2.4821×10^{8}	2.5310×10^{5}	2.5310×10^{9}	2.5310×10^{2}	2.5310×10^{6}	3.6000×10^{3}	5.1841×10^{5}	1.0000	1.4400×10^{2}
LB(F)HR/FT^2	1.7237×10^{8}	1.7237×10^{6}	1.7577×10^{3}	1.7577×10^{7}	1.7577	1.7577×10^{4}	2.5001×10^{1}	3.6001×10^{3}	6.9446×10^{-3}	1.0000
GM(M)/SEC CM	1.0000×10^{2}	1.0000	1.0197×10^{-3}	1.0197×10^{1}	1.0197×10^{-6}	1.0197×10^{-2}	1.4504×10^{-5}	2.0886×10^{-3}	4.0289×10^{-9}	5.8016×10^{-7}
GM(M)/SEC M	1.0000	1.0000×10^{2}	1.0197×10^{-5}	1.0197×10^{-1}	1.0197×10^{-8}	1.0197×10^{-4}	1.4504×10^{-7}	2.0886×10^{-5}	4.0289×10^{-11}	5.8016×10^{-9}
GM(M)/HR CM	2.7778×10^{-2}	2.7778×10^{-4}	2.8325×10^{-7}	2.8325×10^{-3}	2.8325×10^{-10}	2.8325×10^{-6}	4.0289×10^{-9}	5.8017×10^{-7}	1.1191×10^{-12}	1.6116×10^{-10}
GM(M)/HR M	2.7778×10^{-6}	2.7778×10^{-8}	2.8325×10^{-9}	2.8325×10^{-5}	2.8325×10^{-12}	2.8325×10^{-8}	4.0289×10^{-11}	5.8017×10^{-9}	1.1191×10^{-14}	1.6116×10^{-12}
KG(M)/SEC CM	1.0000×10^{5}	1.0000×10^{3}	1.0197	1.0197×10^{4}	1.0197×10^{-3}	1.0197×10^{1}	1.4504×10^{-2}	2.0886	4.0289×10^{-8}	5.8016×10^{-6}
KG(M)/SEC M	1.0000×10^{3}	1.0000×10^{1}	1.0197×10^{-2}	1.0197×10^{2}	1.0197×10^{-5}	1.0197×10^{-1}	1.4504×10^{-4}	2.0889×10^{-2}	4.0289×10^{-8}	5.8016×10^{-6}
LB(M)/SEC IN	1.7858×10^{4}	1.7858×10^{2}	1.8210×10^{-1}	1.8210×10^{3}	1.8210×10^{-4}	1.8210	2.5901×10^{-3}	3.7298×10^{1}	7.1948×10^{-7}	1.0360×10^{-4}
LB(M)/SEC FT	1.4882×10^{3}	1.4882×10^{1}	1.5175×10^{-2}	1.5175×10^{2}	1.5175×10^{-5}	1.5175×10^{-1}	2.1585×10^{-4}	3.1083×10^{-2}	5.9958×10^{-8}	8.6639×10^{-6}
LB(M)/HR IN	4.9605	4.9605×10^{-2}	5.0582×10^{-5}	5.0582×10^{-1}	5.0582×10^{-8}	5.0582×10^{-4}	7.1947×10^{-7}	1.0361×10^{-4}	1.9985×10^{-10}	2.8779×10^{-8}
LB(M)/HR FT	4.1338×10^{-1}	4.1338×10^{-3}	4.2152×10^{-6}	4.2152×10^{-2}	4.2152×10^{-9}	4.2152×10^{-5}	5.9957×10^{-8}	8.6339×10^{-6}	1.6655×10^{-11}	2.3983×10^{-9}

gradient of the fluid between the plates. The proportionality factor (μ) is called the coefficient of viscosity or the absolute viscosity of the fluid.

It is obvious that the units of absolute viscosity must be the product of a force and time divided by an area if Eq. 1 is to be homogeneous from a dimensional standpoint. One name often used for expressing the absolute viscosity of a fluid is the poise, the units of which are the dyne seconds per square centimeter. Sometimes usage is made of the centipoise which is equal to one hundredth of a poise or the millipoise which is equal to one thousandth of a poise.

Dimensional Analysis

Let the symbols F, M, L, and T represent force, mass, length or linear dimension, and time respectively. Area is then represented by L^2 and acceleration by LT^{-2}. One method for expressing the units for a poise as previously defined would be FT/L^2 or FTL^{-2}. Since force is proportional to the product of mass and acceleration, the symbol for force may be replaced by its equivalent MLT^{-2}, which gives $ML^{-1}T^{-1}$ for the units of absolute viscosity. Consequently, force or mass units may be employed for absolute viscosity units, and, as a result, serious conversion difficulties may result if one is not familiar with all of the various fundamental units employed in engineering work.

A discussion of some of the systems used is therefore important for a clear understanding of the method used in converting the units for viscosity from one system to another.

Relationship of Mass and Force

According to Newton's second law of motion, the force acting upon a mass is proportional to the product of the mass and the acceleration produced. This may be stated as follows:

$$\text{Force} = (k)\ (\text{Mass})\ (\text{Acceleration}) \qquad (2)$$

or

$$F = k\,M\,L\,T^{-2} \qquad (3)$$

where k represents a proportionality constant. It is possible to make k equal to unity if suitable units are selected for the various terms.

Since the dimensions of length and time are more or less fixed, they are usually selected as two of the fundamental units. It is therefore possible to select either force or mass as the other fundamental unit. By means of a suitable choice of force and mass units the proportionality constant k may be made equivalent to unity. The two ways for doing this are: first, to select the mass and acceleration units and choose the force unit so that k is unity; and, second, to select the force and acceleration units and choose the mass unit to make k equal to unity.

By means of the first method the pound mass and an acceleration of 1 ft. sec.$^{-2}$ are selected and the force unit is then chosen so

Table 1B. Continuation of Table 1A. Locate the original units in the vertical left hand column, then follow horizontally and take the multiplying factor from directly under the new units

	GM(M)/SEC CM	GM(M)/SEC M	GM(M)/HR CM	GM(M)/HR M	KG(M)/SEC CM	KG(M)/SEC M	LB(M)/SEC IN	LB(M)/SEC FT	LB(M)/HR IN	LB(M)/HR FT	SLUG/SEC IN	SLUG/SEC FT	SLUG/HR IN	SLUG/HR FT
CENTIPOISE	1.0000×10^{-2}	1.0000	3.6000×10^{1}	3.6000×10^{3}	1.0000×10^{-5}	1.0000×10^{-3}	5.5998×10^{-5}	6.7197×10^{-4}	2.0159×10^{-1}	2.4191	1.7405×10^{-6}	2.0886×10^{-5}	6.2656×10^{-3}	7.5188×10^{-2}
POISE	1.0000	1.0000×10^{2}	3.6000×10^{3}	3.6000×10^{5}	1.0000×10^{-3}	1.0000×10^{-1}	5.5998×10^{-3}	6.7197×10^{-2}	2.0159×10^{1}	2.4191×10^{2}	1.7408×10^{-4}	2.0886×10^{-3}	6.2656×10^{-1}	7.5188
GM(F)SEC/CM^2	9.8067×10^{2}	9.8067×10^{4}	3.5304×10^{6}	3.5304×10^{8}	9.8067×10^{1}	9.8067×10^{3}	5.4916	6.5898×10^{1}	1.9769×10^{4}	2.3723×10^{5}	1.7068×10^{1}	2.0482	6.1444×10^{2}	7.3733×10^{3}
GM(F)SEC/M^2	9.8067×10^{-2}	9.8067	3.5304×10^{2}	3.5304×10^{4}	9.8067×10^{-5}	9.8067×10^{-3}	5.4916×10^{-6}	6.5898×10^{-3}	1.9769	2.3723×10^{1}	1.7068×10^{-4}	2.0482×10^{-3}	6.1444×10^{-2}	7.3733×10^{-1}
KG(F)SEC/CM^2	9.8067×10^{5}	9.8067×10^{7}	3.5304×10^{9}	3.5304×10^{11}	9.8067×10^{2}	9.8067×10^{4}	5.4916×10^{3}	6.5898×10^{4}	1.9769×10^{7}	2.3723×10^{8}	1.7068×10^{2}	2.0482×10^{3}	6.1444×10^{5}	7.3733×10^{6}
KG(F)SEC/M^2	9.8067×10^{1}	9.8067×10^{3}	3.5304×10^{5}	3.5304×10^{7}	9.8067×10^{-2}	9.8067	5.4916×10^{-1}	6.5898	1.9769×10^{3}	2.3723×10^{4}	1.7068×10^{-2}	2.0482×10^{-1}	6.1444×10^{1}	7.3733×10^{2}
LB(F)SEC/IN^2	6.8947×10^{4}	6.8947×10^{6}	2.4821×10^{8}	2.4821×10^{10}	6.8947×10^{1}	6.8947×10^{3}	3.8609×10^{2}	4.6330×10^{3}	1.3899×10^{6}	1.6679×10^{7}	1.2000×10^{1}	1.4400×10^{2}	4.3199×10^{4}	5.1840×10^{5}
LB(F)SEC/FT^2	4.7880×10^{2}	4.7880×10^{4}	1.7237×10^{6}	1.7237×10^{8}	4.7880×10^{-1}	4.7880×10^{1}	2.6812	3.2174	9.6521×10^{3}	1.1583×10^{5}	8.7334	1.0000	3.0000	3.6000×10^{2}
LB(F)HR/IN^2	2.4821	2.4821×10^{2}	8.9356×10^{3}	8.9356×10^{5}	2.4821×10^{3}	2.4821×10^{5}	1.3899×10^{6}	1.6679×10^{7}	5.0037×10^{8}	6.0044×10^{9}	4.3199×10^{4}	5.1841×10^{5}	1.5552×10^{8}	1.8662×10^{9}
LB(F)HR/FT^2	1.7237	1.7237×10^{2}	6.2053×10^{3}	6.2053×10^{5}	1.7237×10^{3}	1.7237×10^{5}	9.6524×10^{3}	1.1583×10^{5}	3.4748×10^{7}	4.1698×10^{8}	3.0000×10^{3}	3.6000×10^{4}	1.0800×10^{8}	1.2960×10^{9}
GM(M)/SEC CM	1.0000	1.0000×10^{2}	3.6000×10^{3}	3.6000×10^{5}	1.0000×10^{-3}	1.0000×10^{-1}	5.5998×10^{-3}	6.7197×10^{-2}	2.0159×10^{1}	2.4191×10^{2}	1.7405×10^{-4}	2.0886×10^{-3}	6.2656×10^{-1}	7.5188
GM(M)/SEC M	1.0000×10^{-2}	1.0000	3.6000×10^{1}	3.6000×10^{3}	1.0000×10^{-5}	1.0000×10^{-3}	5.5998×10^{-6}	6.7197×10^{-4}	2.0159×10^{-1}	2.4191	1.7405×10^{-6}	2.0886×10^{-5}	6.2656×10^{-3}	7.5188×10^{-2}
GM(M)/HR CM	2.7778×10^{-4}	2.7778×10^{-2}	1.0000	1.0000×10^{2}	2.7778×10^{-7}	2.7778×10^{-5}	1.5555×10^{-6}	1.8666×10^{-5}	5.5998×10^{-3}	6.7198×10^{-2}	4.8346×10^{-6}	5.8017×10^{-5}	1.7405×10^{-4}	2.0886×10^{-3}
GM(M)/HR M	2.7778×10^{-6}	2.7778×10^{-4}	1.0000×10^{-2}	1.0000	2.7778×10^{-9}	2.7778×10^{-7}	1.5555×10^{-8}	1.8666×10^{-7}	5.5998×10^{-5}	6.7198×10^{-4}	4.8346×10^{-10}	5.8017×10^{-9}	1.7405×10^{-6}	2.0886×10^{-5}
KG(M)/SEC CM	1.0000×10^{-3}	1.0000×10^{1}	3.6000×10^{2}	3.6000×10^{4}	1.0000	1.0000×10^{2}	5.5998	6.7197	2.0159×10^{3}	2.4191×10^{4}	1.7405×10^{-1}	2.0886	6.2656×10^{2}	7.5188×10^{3}
KG(M)/SEC M	1.0000×10^{-1}	1.0000×10^{1}	3.6000×10^{3}	3.6000×10^{5}	1.0000×10^{-2}	1.0000	5.5998×10^{-2}	6.7197×10^{-1}	2.0159×10^{2}	2.4191×10^{3}	1.7405×10^{-3}	2.0886×10^{-2}	6.2656	7.5188×10^{1}
LB(M)/SEC IN	1.7858	1.7858×10^{2}	6.4289×10^{3}	6.4289×10^{5}	1.7858	1.7858×10^{1}	1.0000	1.2000	3.6000×10^{3}	4.3200×10^{4}	3.1081	3.7298	1.1189	1.3427
LB(M)/SEC FT	1.4882	1.4882×10^{2}	5.3575	5.3575×10^{5}	1.4882	1.4882×10^{2}	8.3333	1.0000	3.0000	3.6000×10^{3}	2.5902	3.1083	9.3243	1.1189
LB(M)/HR IN	4.9605×10^{-4}	4.9605	1.7858	1.7858×10^{3}	4.9605×10^{-6}	4.9605×10^{-3}	2.7778×10^{-4}	3.3333×10^{-3}	1.0000	1.2000	8.6337×10^{-6}	1.0361×10^{-4}	3.1081×10^{-2}	3.7297
LB(M)/HR FT	4.1338×10^{-3}	4.1338×10^{-1}	1.4882	1.4882×10^{3}	4.1338×10^{-5}	4.1338×10^{-3}	2.3148×10^{-5}	2.7778×10^{-4}	8.3333	1.0000	7.1946×10^{-7}	8.6339×10^{-6}	2.5901×10^{-3}	3.1081×10^{-2}

that k is unity. In this case the resulting force unit is known as the poundal and is defined as that force which when acting upon a pound mass will accelerate it 1 ft. sec.$^{-2}$. Using these units Eq. 2 becomes

$$(1)\ \text{Poundal} = (1)\ \text{Pound Mass}\ (1)\ \text{ft. sec.}^{-2} \qquad (4)$$

From this relation the force of gravity in a given locality which acts on a pound mass is equal to g poundals where g is the local acceleration due to gravity. In a similar manner, if the gram mass and an acceleration of 1 cm. sec.$^{-2}$ are selected, then the resulting unit is known as the dyne. The dyne is therefore the force which will accelerate a gram mass 1 cm. sec.$^{-2}$.

$$(1)\ \text{Dyne} = 1\ \text{Gram Mass}\ (1)\ \text{cm. sec.}^{-2} \qquad (5)$$

The other method used for making the value of k equal to unity is to choose the standard force pound and the acceleration of 1 ft. sec.$^{-2}$ as the fundamental units and select the mass unit so that k is unity. The standard force pound is defined as the force which will accelerate the standard pound mass 32.1740 ft. sec.$^{-2}$ or 980.665 cm. sec.$^{-2}$. The resulting unit of mass is called the slug and is equal to the mass which would be accelerated 1 ft. sec.$^{-2}$ when acted upon by a standard force pound. This relation is expressed by the following:

$$(1)\ \text{Standard Force Pound} = (1)\ \text{Slug}\ (1)\ \text{ft. sec.}^{-2} \qquad (6)$$

From the definition of the standard force pound the following relation may be written:

$$(1)\ \text{Standard Force Pound} = (1)\ \text{Mass Pound}\ (32.1740)\ \text{ft. sec.}^{-2} \qquad (7)$$

Equating these two equations gives the relation that one slug is equivalent to 32.1740 mass pounds. It is important to note that the standard force pound is independent of the local acceleration due to gravity. The local gravitational pound force or weight is defined as the force which accelerates a mass pound equal to the local acceleration value. This may be written as follows:

$$(1)\ \text{Local Gravitational Force or Weight} = (1)\ \text{Mass pound (g) Local acceleration due to gravity} \qquad (8)$$

The local gravitational force or weight may be converted to standard force pounds by solving for the mass pound terms in Eqs. 7 and 8 and equating.

$$\frac{\text{Local Gravitational Force}}{g_{\text{local}}} = \frac{\text{Standard Force Pound}}{32.1740}$$

The engineers of Continental Europe use as the unit of mass in the Metric Gravitational System that mass which will be accelerated one meter sec.$^{-2}$ when acted upon by a force of one kilogram.

Conversions

Knowing the distinctions between the various force and mass units it is possible to convert from one system to another. The following table of symbols will be used in the conversion factor discussion:

Abbreviation or Symbol	Significance
in. or IN.	inch
ft. or FT.	foot
cm. or CM.	centimeter
m or M	meter
sec. or SEC.	second
min. or MIN.	minute
hr. or HR.	hour
lb. or LB.	pound
gm. or GM.	gram
kg. or KG.	kilogram
(F)	designates force
(M)	designates mass

In order to convert one set of absolute viscosity units to any other it is only necessary to write the unit relation and apply the unity conversion factors. The following examples will serve to illustrate the method:

Example I

Convert a viscosity value of 1 centipoise to lb. (F) hr. ft.$^{-2}$ units.* The following results from the fundamental definition of a centipoise:

$$1\ \text{centipoise} = \frac{1}{100}\ \text{poise} = \frac{1\ \text{dyne sec.}}{100\ \text{cm.}^2}$$

The relation between the various units involved are as follows:

$$1\ \text{hr.} = 3600\ \text{sec.}$$
$$1\ \text{cm.}^2 = 0.001076\ \text{ft.}^2$$
$$1\ \text{dyne} = 2.2481 \times 10^{-6}\ \text{lb. (F)}$$

Since these are algebraic equations, it is possible to express them as unity conversion factors.

$$\frac{1\ \text{hr.}}{3600\ \text{sec.}} = 1$$

$$\frac{1\ \text{cm.}^2}{0.001076\ \text{ft.}^2} = 1$$

$$\frac{1\ \text{dyne}}{2.2481 \times 10^{-6}\ \text{lb. (F)}} = 1$$

An equation when multiplied by unity is unaltered, therefore these unity conversion factors may be used in the original relation without altering the results. Writing the original relation and multiplying by the necessary conversion factors gives:

$$1.0\ \text{centipoise} = \left[\frac{1.0\ \text{dyne sec.}}{100\ \text{cm.}^2}\right] \frac{\left[\frac{1\ \text{hr.}}{3600\ \text{sec.}}\right]\left[\frac{1\ \text{cm.}^2}{0.001076\ \text{ft.}^2}\right]}{\left[\frac{1\ \text{dyne}}{2.2481 \times 10^{-6}\ \text{lb. (F)}}\right]}$$

$$= \frac{1.0 \times 2.2481 \times 10^{-6}\ \text{lb. (F) hr.}}{100 \times 3600 \times 0.001076\ \text{ft.}^2}$$

$$= 1.0 \times 5.8016 \times 10^{-9}\ \frac{\text{lb. (F) hr.}}{\text{ft.}^2}$$

*The term (F) and (M) which appear in parenthesis frequently in the text, equations and tables following lb., gm. and kg., have no significance beyond identifying these as mass (M) or force (F) units.

From this one observes that the number 5.8016 $\times$ 10^{-9} when multiplied by the original viscosity value in centipoise gives the desired value in lb. (F) hr. ft.$^{-2}$ units.* This multiplying factor will be termed the viscosity conversion factor.

Example II

Convert a viscosity value of 1 centipoise to slug hr.$^{-1}$ ft.$^{-1}$ units.

1 cm. = 0.032808 ft.
1 lb. (Mass) = 453.59 grams (Mass)
1 slug = 32.1740 lb. (Mass)

1 centipoise =

$$\frac{\left[\frac{0.01 \text{ dyne sec.}}{\text{cm.}^2}\right]\left[\frac{1 \text{ gm. (M) cm.}}{1 \text{ dyne sec.}^2}\right]\left[\frac{1 \text{ cm.}}{0.032808 \text{ ft.}}\right]\left[\frac{1 \text{ lb. (M)}}{453.59 \text{ gm. (M)}}\right]\left[\frac{1 \text{ slug}}{32.1740 \text{ lb. (M)}}\right]}{\left[\frac{1 \text{ hr}}{3600 \text{ sec.}}\right]}$$

$$= 1\ (7.5188 \times 10^{-2})\ \frac{\text{slug}}{\text{hr. ft.}}$$

In this example 7.5188 $\times$ 10^{-2} represents the conversion factor.

Example III

Convert an absolute viscosity value of 1 lb. (M) hr.$^{-1}$ ft.$^{-1}$ to slug hr.$^{-1}$ ft.$^{-1}$ units.*

$$\frac{\text{1 lb. (M)}}{\text{hr. ft.}} = \left[\frac{\text{1 lb. (M)}}{\text{hr. ft.}}\right]\left[\frac{\text{1 slug}}{\text{32.1740 lb. (M)}}\right]$$

$$= 1\ (3.1081 \times 10^{-2})\ \frac{\text{slug}}{\text{hr. ft.}}$$

Here 3.1081 $\times$ 10^{-2} represents the conversion factor.

The same procedure has been followed in working out the conversion factor table by means of which the actual calculation of the conversion factor may be avoided. By the same analysis conversion factors have been calculated for other combinations of units and are tabulated in the table. In order to locate a conversion factor, locate the units for viscosity in the vertical left hand column and move in a horizontal direction until directly under the desired units and read the conversion factor. This factor, when multiplied by the original value, will convert the viscosity over to a new value having the desired units.

ELIMINATING GASES FROM THE WATER CYCLE

DELETERIOUS effect of oxygen, carbon dioxide and ammonia in the feedwater cycle is a prevalent and perplexing problem. Opinions vary greatly as to the safe allowable content of these gases in the system, according to a recent E.E.I. report. Oxygen may be introduced into the feedwater system through leakage wherever the steam or condensate is below atmospheric pressure, through exposure of the condensate to the air as in surge tanks or clear well, and, in the make-up whether it be treated water or supplied by evaporators.

The majority of companies rely on deaerating heaters and these heaters provide one central point in the heat cycle for the removal of oxygen and CO_2 entering the feedwater system. One company has found it necessary to hold the pressure in the deaerator within narrow limits and above 1.25 p.s.i. gage to obtain satisfactory deaeration and its operation is adversely affected by fluctuations in the temperature of the entering feedwater.

On the other hand in many plants the deaerator pressure automatically changes with the change in extraction pressure and turbine loading from above to below atmosphere, apparently with satisfactory results, and certain deaerator manufacturers will guarantee oxygen-content as low as 0.005 c.c. per liter under these conditions.

A number of companies rely entirely upon deaeration in the condenser. In some of the older condensers the removal of oxygen has not been satisfactory, but in the modern designs many companies believe that deaeration is as complete as is possible with any deaerating heater.

One company prevents oxygen contamination through the surge tanks by the use of floating covers. Some companies steam seal the surge tank and others find little, if any, contamination from open surge tanks, provided that the water level does not fluctuate rapidly or is not agitated. Make-up water from the clear well injected into the condenser was reported as giving trouble with oxygen contamination when injected through an open pipe near the bottom of the condenser, but was completely deaerated when sprayed through a perforated pipe at the top of the condenser.

Oxygen in the discharge from the low pressure drain pumps was reported by several companies. One reported remedying this condition by a special deaerating hotwell on some heaters. Two companies report the use of deaerating hotwells on the condenser which not only deaerate the heater drains but elevate the condensate temperature sufficiently above the exhaust steam temperature to recover a large portion of the heat in the drains.

Carbon dioxide, liberated in the evaporator by the decomposition of the bicarbonates, is reported by several companies to have caused corrosion in the evaporator condenser or stage heaters. This was corrected by installing additional baffles, by relocating the vents, or by getting more adequate venting from the existing vents.

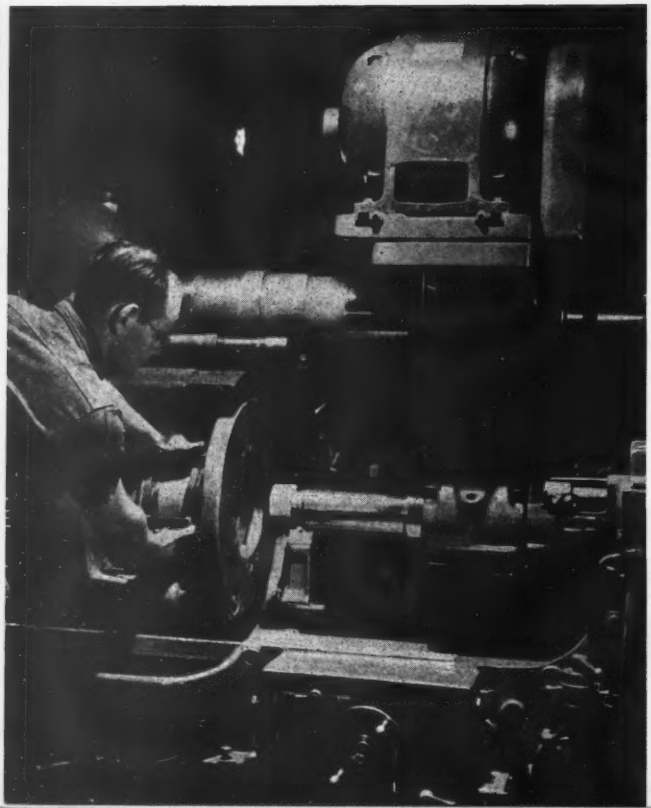
Elimination of ammonia from the feedwater system has been receiving increased attention due to numerous cases of corrosion attributed to this cause. Ammonia may be formed by the decomposition of organic matter, nitrates or nitrites in the raw water, either in the evaporator or in the boiler. Since ammonia is very soluble, it may become concentrated in the condenser by reabsorption of the inter-cooler and after-condenser, the condensate from which is usually trapped back to the condenser.

By discharging the after-condenser drips to waste, several companies reported a noticeable reduction in the ammonia content of the condensate. Drips from heater vent condensers have also been found to contain ammonia and have been discharged to waste. Ammonia is reported to be more prevalent in winter with cold circulating water than in summer with warm circulating water, due probably to the greater absorption of ammonia with the colder condensate.

THE CONSTRUCTION OF

Industry needs more motors—more and better motors—to keep the wheels of production whirling in America's all out efforts for national defense. Most of us know what a modern motor looks like, but few of us know how they are made in quantity. So on this page we take you into the factory—General Electric's factory, at Lynn, Mass., to show you step by step, how their "Tri-Clad" motors are made. Triply protected; by synthetic, all-American, insulation against electrical breakdown; by cast iron against physical damage and by improved bearing construction against operating wear and tear, these motors are well fitted to industry's needs. In these pictures, each step from the pouring of the casting for the stator frame to final inspection and crating is shown. In motor manufacture as in automobile manufacture, streamline production methods guarantee accuracy, quality and uniformity of product

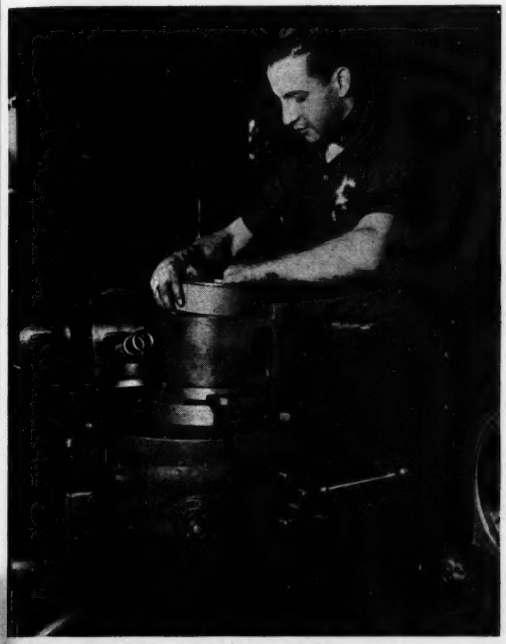
1. The first step in the process of making a motor is in pouring the stator frame. This is shown at the left. Molds made by the booking process move on a belt conveyor past a pouring ladle suspended on a monorail. This conveyor carries filled molds through a cooling chamber to a "shakeout." Subsequently, fork trucks hustle the castings along to the tumbling mills, chippers, and painting machines



2. After having been given a coat of Glyptal 1201 Red enamel, the cast iron stator is machined to close concentric tolerances by the machine shown above. This is an automatic double-end boring mill. Both lamination lands and rabbets for end shields are bored on the same machine as shown in this view

3. Motors help to make motors. At the left a precision grinding machine, itself motorized with a motor of the very type it helps to make, is used to form accurate, perfectly round stator bores. Cores are made concentric to endshield rabbet dimensions to assure a uniform air-gap and perfect alinement

MODERN ELECTRIC MOTORS



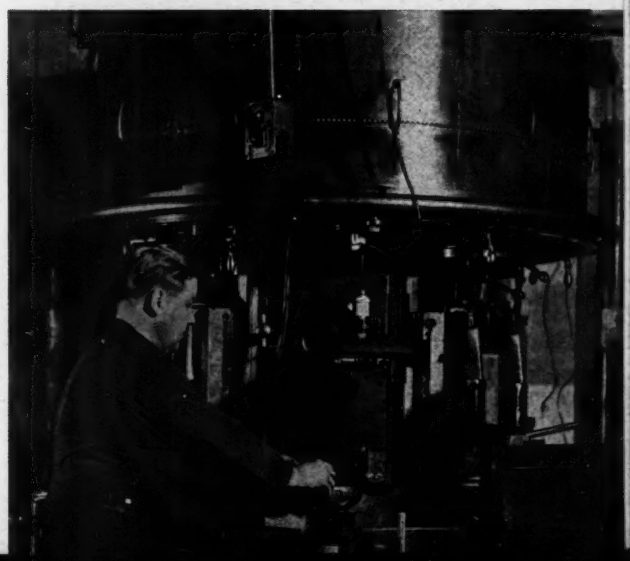
4. The photograph at the left shows the correct number of silicon steel laminations being stacked snugly in the stator frames. Laminations are keyed to withstand rotational torques and are locked tightly into the frame under pressure to make a rigid and perfectly fitting core

5. Right. Reinforced slot tubes have been inserted. Coils of Formex wire are now inserted by hand and wedged solidly in place in the slots. The coils are wound in such a way as to minimize end connections

6. Above. By gravity conveyor and monorail, the stators travel to this station where end connections are made by welding—not soldering. The end connections are next insulated and laced tightly to the end turns. Impregnated with synthetic resins, a spray coat of Glyptal 1201 Red, more bakes, and out comes a solid lasting assembly resistant to moisture, and rough handling

7. Above, right. Rotor shafts of high-grade stock are machined to size. Coolant pours over shaft as it is being machined. Shoulders for the motor bearings and the shaft extensions are automatically cut on the machine shown in this photograph

8. Right. Next we look on the end shields. Delivered from the foundry they are machined to the same close tolerances as the stator on this multiple-station, automatically indexing machine tool



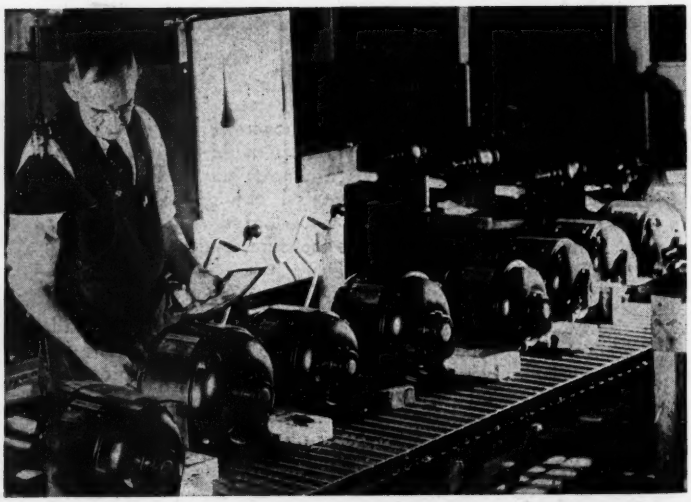
9. At the left we see the aluminum rotor windings being cast. Here the molten aluminum is being poured into the mold. A low inertia, one piece practically indestructible rotor results. Fans are cast integral with the winding. The rotor is then pressed on the shaft

10. Above. Now comes the final assembly of the different parts into the complete motor. This is done on a gravity conveyor, each motor having some part added to it by hand operated power tools

11. Right. The assembled motor is now ready for the final finish. In the paint room where powerful fans exhaust the fumes, the motors are suspended on hand operated electric hoists and given a coat of Glyptal

12. Right, below. After painting the motors are given careful and complete inspection and running tests. Then the monogram end caps and nameplates are put in place. Here the motors are given their final inspection

13. Below. Along the conveyor from final inspection the motors go to the shipping area where each motor is crated, then transferred by electric hoists to trailers and sent on their way to the outside world for use



Piping Inspection Demanded Under Defense Loads. I

Within the past year and a half nearly every industrial plant in the country has been converted from a producer of peace-time products to an establishment manufacturing some form or part of war equipment. In some cases major changes in equipment have been necessary, in others minor, in nearly all cases, however, factories have been compelled to increase their production with as little change in service piping as possible. So sudden has been the increase in demands on piping that in many cases time was not allowed for making repairs or replacements that had been neglected during the years of the depression. This series of two articles outlines a procedure for the inspection of piping systems to determine the faults and weaknesses of design of the system and to arrange for the necessary repairs and replacements

SUDDEN adjustments are sure to put a strain on machinery, particularly if that adjustment is in the direction of more load. Industrial machinery and equipment have been subjected to just such an adjustment by the requirements of the National Defense Program. While piping is not usually classed as machinery, and in most factory plants the piping system has been in continuous service during the entire period of the depression, it does represent the blood stream of the factory and, during the inactive years of the depression, deterioration took its toll out of proportion to the service rendered due to curtailment of normal maintenance. It is time now to take cognizance of this fact and make up for the neglect that has been all too prevalent in power plants and factories.

Where to begin and how to proceed are the first questions encountered. Today as never before, the answers will come as they are forced upon maintenance men. Leaks, cracks, breaks and other acute pipe ailments demand immediate attention and leave no alternative as to which defect requires first attention, but it is the planned maintenance that is more effective in keeping all sections of a piping system in continuous working condition. It does not pay to wait for a failure if a doubtful condition can be detected and remedied. It is, therefore, to inspection, preventive replacement and repair prior to actual breaking or complete failure that the maintenance man should turn his attention. The outline of procedure which follows is intended as a guide in carrying out the work of pipe inspection in a logical, thorough manner.

Piping Drawings

Most plants constructed within the last 20 yr. had their piping systems laid out according to the engineer's drawing and such a drawing should be made available to the engineer who is placed in charge of the inspection work. This assembly drawing should include all piping systems in the plant, water, steam, oil, etc. Quite likely many changes in the piping hook-ups have been made due to replacements of units served, changes in factory equipment and, in recent months, expansion of factory facilities.

Because of these conditions, it is important that the piping drawings be thoroughly revised to make them conform with the present arrangement. An assembly drawing is important to the inspector as it gives him a means of tracing the course of the steam, water or other liquid through the entire plant to the equipment where it is used. In the hurry of making a new connection, a pipe fitter may have carried a lead from a conveniently located line, but by so doing interfered with service to other equipment. Such a condition may not have been evident under reduced load conditions, but with increased activity, reduced pressure due to pipe friction may cause inefficient operation.

In addition to the assembly drawing, which may show piping as one line and fittings by symbols in order to avoid confusion, a more complete drawing should

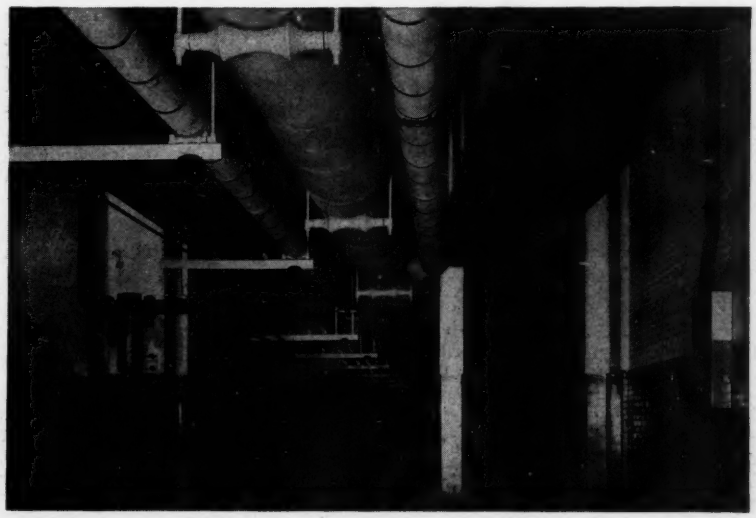


Fig. 1. These pipe lines leading from the power house to the factory illustrate the importance the designer placed on supports and rollers

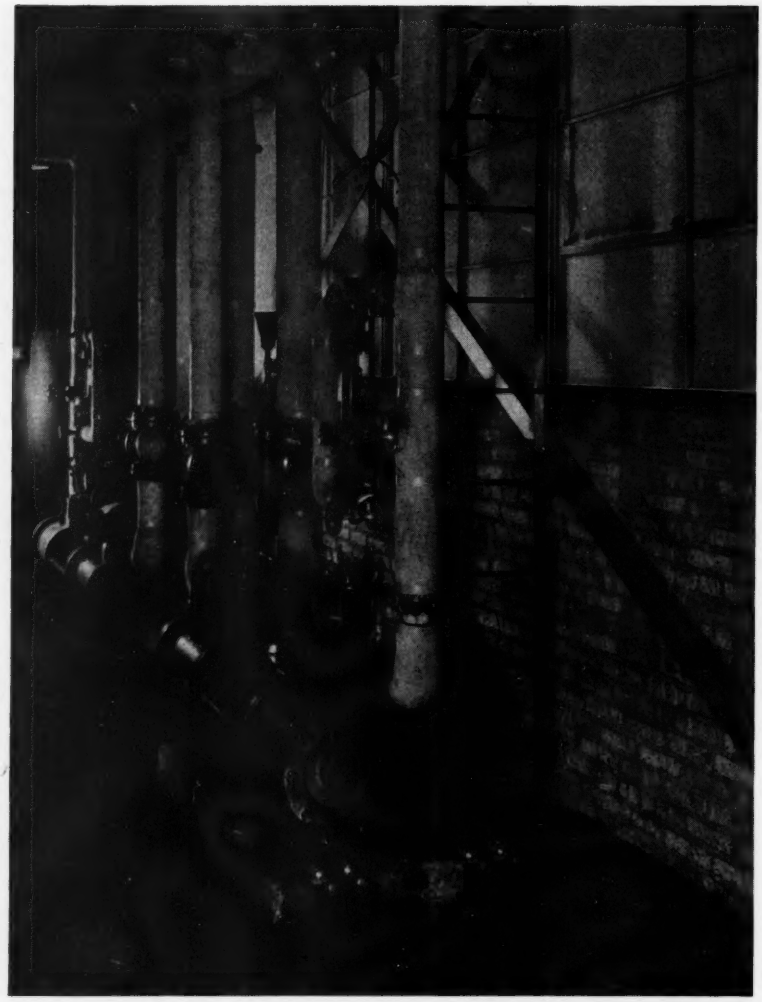


Fig. 2. It is not uncommon to find flanges, valves and unions uncovered. It may be convenient but it causes continuous waste of heat

be made of each section of the plant where piping is located. These drawings should show the piping in two lines and give details of piping design, dimensions, specific locations of pipe runs, direction and amount of pitch, fittings with their sizes and types, hangers, anchors and supports, separators, drains, traps, expansion joints and loops. In fact every detail of the system should be indicated on these sectional drawings of the piping system.

Inasmuch as these two sets of drawings have to do with the piping equipment as a system, another set of drawings which details the hook-up of each unit of equipment to which the piping system is connected, should be supplied to the inspector. As a rule these last drawings are supplied by the manufacturer of the equipment as part of the installation instructions and frequently assist in detecting unsatisfactory operation.

All of these drawings should be kept as a part of the permanent record of the plant and revised with each change made in the piping system. They are of service not only in carrying out piping inspection and maintenance but will guide the engineer in making plans for expansion of service.

Inspection procedure will, of course, vary with circumstances, but in a plant of average size, where a large maintenance crew is not continuously available, the work must be done when the inspecting engineer is not urgently needed at some other assignment. Recognizing that systematic procedure is essential it is well to deal with one department at a time, making a report on all repairs needed immediately and those subject to further investigation. Repairs and replacements should not be started, unless urgent, until the inspection of that particular section of the system has been completed, for the reason that such repairs usually necessitate an interruption in service and, by knowing all the work that should be done, the various repairs can frequently all be accomplished by a single interruption at the most convenient time rather than stopping service several times for short periods.

Piping is a means to an end and not an end in itself, so it would seem logical to start with the equipment served to make sure that the fluid is coming to it and the wastes or returns leaving as desired for it to function properly. It must be delivered in sufficient quantity at the desired time, under specified temperature, pressure, purity, velocity. When specified conditions are met without interruption there is little more that can be asked of the piping system in the way of service.

Inspection may bring out a fault in this service, either serious or trivial, and this fault should be investigated. It may be caused by some undesirable feature in the main or supply line which was not revealed by the inspection of the principal piping, if this work was done first, and thus necessitate a review check-up. The point is, a defect in the ultimate service represents an accumulation of all the faults throughout the entire supply and is more likely to be observed at the unit served than at points along the line, but knowing that it exists is a distinct aid in the inspection of the supply lines.

Individual Hook-Ups

As each individual pipe-connected unit is considered, determine positively that these four items are complied with fully, any deviation should be noted and corrected.

1. That the piping connections are performing their function fully and efficiently in conformity with the unit's service.

2. That the pipe sizes, valves, bypasses, gages and all other appurtenances are in accordance with the manufacturer's recommended hook-up.

3. That piping hook-up has no defects observable to the operator of the equipment, such as leaks, cracks, defective valve operation, defective insulation, water hammer, vibration, loose or broken flange bolts.

4. That no hidden hazards are present in the piping hook-up from the supply line to the unit or the unit to return or waste line. Such hazards may consist of temperature strains, strains due to defective foundations, inadequate or broken pipe supports, unprovided for condensate pockets, incorrectly installed gaskets, corrosion, erosion, obstructions such as scale and rust formation, loose packing or detached or broken parts of valves.

Item (1) can best be checked by conferring with the operator and finding what complaints he may have regarding pressures and their variations during operation, temperatures and their fluctuations; study his control equipment and methods, make note of his operating schedule. The causes of the difficulties he encounters may not be immediately apparent, but with these conditions in mind as inspection proceeds, the accumulation of evidence will point to the offending cause.

Item (2) is determined by a careful check of the actual hook-up with the drawing supplied by the equipment manufacturer. It is not uncommon to find that, when new equipment replaces old, the old connections are disturbed as little as possible and may not be in complete conformity with the new equipment requirements.

Observable defects, item (3), are usually quite apparent but they are likely to become so common that they are neglected. A weeping valve stem may cause little annoyance yet it is not perfect and should be corrected. It may be that the gland packing needs renewing or it may be more serious—a corroded and weakened valve stem, the stem may be bent or the disc improperly attached — careful investigation should be given a condition of this sort, take no explanation for granted, be positive.

To find hidden hazards, item (4) demands as exercise of all the ingenuity an engineer possesses. For this reason a careful study should be made of all notes taken in line with items 1, 2 and 3, if the causes of any defects noted have not been definitely and fully determined. Severe temperature strains may exist without apparent evidence. Usually, however, the observing inspector can find what seems to be remote evidence which when traced to its cause points to stresses that have not been provided for. These will frequently appear in foundation difficulties, piping out of alinement, the equipment slightly out of level, cracked flanges or castings, broken bolts, leaking gaskets. It is unwise to draw conclusions as to causes without careful investigation. To treat the effect without remedying the cause may even accentuate the danger. A leaking joint caused by misalinement may be gasketted as to stop the leak, but in so doing put a severe strain on the flange and flange bolts.

Obstructions in piping are usually indicated by a drop in pressure while the liquid is flowing, usually observable in the operation of the unit served. Corrosion of piping usually gives warning by pinhole leaks before the danger point is reached, but the inspector should know the history of the piping, the age of the piping, the fluid handled, the material of which the piping is made and, if age is against it at the time of the inspection, the line should be opened at some of the most vulnerable points and the interior condition examined for both corrosion and erosion.

(To be continued)

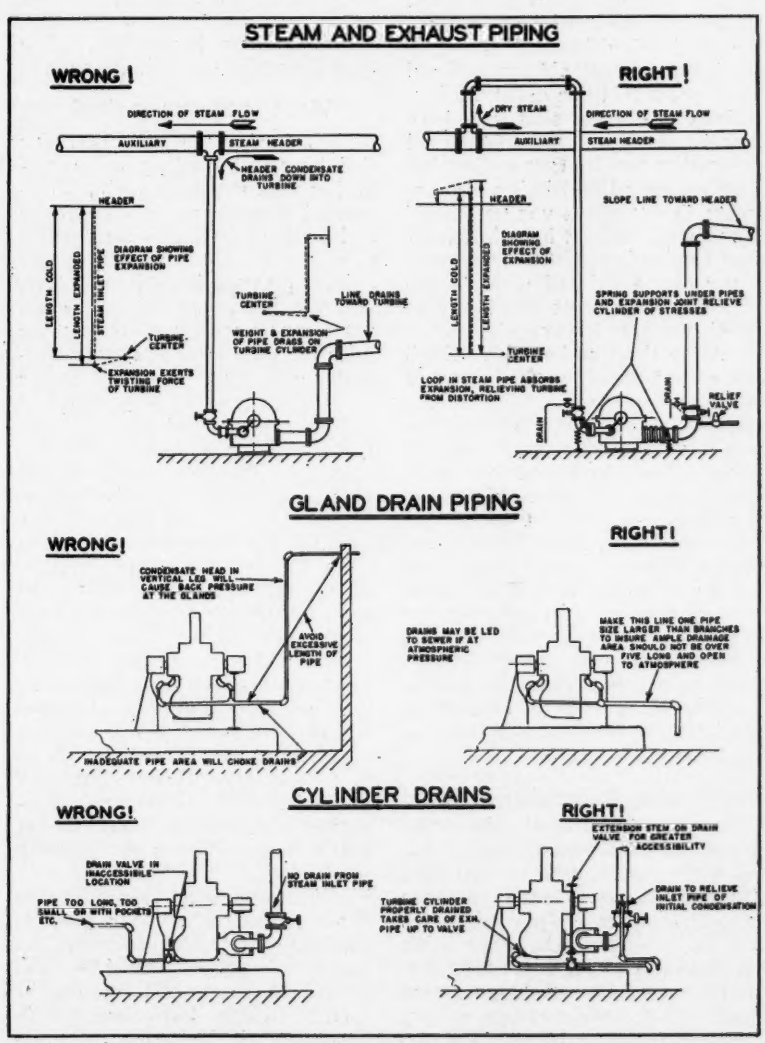

STEAM AND EXHAUST PIPING
WRONG !
RIGHT !
DIRECTION OF STEAM FLOW
AUXILIARY
STEAM HEADER
HEADER CONDENSATE DRAINS DOWN INTO TURBINE
HEADER
DIAGRAM SHOWING EFFECT OF PIPE EXPANSION
LENGTH COLD
LENGTH EXPANDED
STEAM INLET PIPE
TURBINE CENTER
EXPANSION EXERTS TWISTING FORCE OF TURBINE
LINE DRAINS TOWARD TURBINE
WEIGHT & EXPANSION OF PIPE DRAGS ON TURBINE CYLINDER
DRY STEAM
LOOP IN STEAM PIPE ABSORBS EXPANSION, RELIEVING TURBINE FROM DISTORTION
SLOPE LINE TOWARD HEADER
SPRING SUPPORTS UNDER PIPES AND EXPANSION JOINT RELIEVE CYLINDER OF STRESSES
DRAIN
RELIEF VALVE
GLAND DRAIN PIPING
WRONG!
RIGHT!
CONDENSATE HEAD IN VERTICAL LEG WILL CAUSE BACK PRESSURE AT THE GLANDS
AVOID EXCESSIVE LENGTH OF PIPE
INADEQUATE PIPE AREA WILL CHOKE DRAINS
DRAINS MAY BE LED TO SEWER IF AT ATMOSPHERIC PRESSURE
MAKE THIS LINE ONE PIPE SIZE LARGER THAN BRANCHES TO INSURE AMPLE DRAINAGE AREA SHOULD NOT BE OVER FIVE LONG AND OPEN TO ATMOSPHERE
CYLINDER DRAINS
WRONG!
RIGHT!
DRAIN VALVE IN INACCESSIBLE LOCATION
PIPE TOO LONG, TOO SMALL OR WITH POCKETS ETC.
NO DRAIN FROM STEAM INLET PIPE
TURBINE CYLINDER PROPERLY DRAINED TAKES CARE OF EXH. PIPE UP TO VALVE
EXTENSION STEM OR DRAIN VALVE FOR GREATER ACCESSIBILITY
DRAIN TO RELIEVE INLET PIPE OF INITIAL CONDENSATION

Fig. 3. Some wrongs and rights in the piping of small turbines

Defense Dominates Louisville Meeting

"Engineers are basically at the bottom of winning this war and the only alternative of not doing the job is to be beaten—there can be no draw," President William A. Hanley tells the A.S.M.E. at the Louisville meeting, Oct. 13 to 15. Registration 304.

By Richard H. Morris
Engineering Editor

TRADITIONAL Kentucky boasts of its Fair Women, Fine Whiskey and Fast Horses. Modern Louisville accepts these as essential features of any well established Southern community and basking in a Defense Boom, which brought a 20 per cent increase in population in the last 6 mo., now boasts of its new industries, deplores the traffic situation, debates the housing problem and screened by Mayor Scholtz' bombardment of statistics on plant production, whispers that he is soon to take over Mayor La Guardia's job on Civilian Defense.

Southern hospitality being what it is, visitors with an old fashioned interest in cigarette factories, distilleries, scenery and even golf had every whim anticipated, with a horse show thrown in for good measure. The temper of the meeting was definitely Defense, however, and the keynote was sounded by President William A. Hanley[1] at a luncheon on the first day when he said in part:

"The Nation is confronted with two critical problems: the immediate necessity of winning the war; and the future necessity of transforming a war machine to peace time pursuits and solving the related social, economic and financial problems without passing them on to future generations. This last, must be planned for now and consists of two major parts: absorption of millions of war workers to normal industry without the chaos which would mean a change in the form of government; and, a fiscal policy which will retire the tremendous national debt without bankruptcy, for, 'Dictators are the receivers of bankrupt republics.'"

Out of a total of 54,000,000 U. S. workers, he estimated that in 1942, some 11,000,000 will be engaged in war work and in 1943 this will be more than doubled. At no time from 1930 to 1940 was unemployment below 8,000,000 so that this phase of the post war problem is not one to be taken lightly. Should the war continue 2 or 3 yr., the national debt will probably reach a figure of half our national wealth of 300 billion dollars. Figuratively he feels that we have reached the point where fat stored up during the last generation has been consumed and it is necessary to get to a "pay as you go basis." By way of contrast he pointed out that England started this war with a per capita debt of about $1000 which is just about the figure at which we should emerge from it.

As to the war he said: "Engineers are basically at the bottom of winning this war . . . and make no mistake, we are in the war whether you think we should be or not . . . taken (there) by elected representatives . . . and to learn the reasons I wish everyone of you would read just two books, *Mein Kampf* and *Berlin Diary* . . . Uphold the hands of the President and of Congress . . . forget we are anything but Americans . . . win the war . . . solve the problems and do not pass them on to our children . . . and remember what an awful calamity it would be to win abroad and lose at home."

The Coming Golden Age of Wood

From the technical side of the program, the banquet meeting was of wide general interest although devoted entirely to the part the wood industries are playing in the defense program. Far from being dead as a Dodo, the plastic plane which received so much newspaper publicity a few years ago is very much alive. Technically it's a plywood plane and the plastic or synthetic resin comes in only in the bond to hold the laminations together.

Had these been available in 1930 the metal plane might never have reached the stage of development that it has. Germany was building wood planes till shortly before the war; Italy was building considerable quantities at least up to the entry into the war, while France, England and our own army was doing considerable experimental work. Shortage of light metals has intensified the work on wood and at present in this country some 46 companies are making 30 wooden airplane parts. It is not likely that large planes will ever again be built completely of wood but certain wooden parts now used as an expedient will probably continue to hold their place permanently in competition with metal. At the present time the airplane propellers situation is critical. Wood propellers while not as good as hollow steel are, it was said, better than the present aluminum ones.

Wood as Strong as Steel

Wood may be stabilized for shrinking and swelling by impregnating with synthetic resin. Compressed it can be made with tensile and bending strengths comparable to mild steel. Contrary to popular opinion plywood is not inexpensive, however, and in normal times could not compete with steel on a price basis for such service as say refrigerator cabinets.

It may, however, be moulded in odd shapes and has been successfully used for small boats for the past 2 yr. The speed with which it may be applied to defense needs is indicated by the fact that the army recently placed an order for quantities of small boats. The first of these, made with 7 plys, was turned out a month after templates for the moulds reached the plant. In fact, actual and prospective developments in this field are so promising that plywood and pre-fabricated houses were hailed as the solution of the post war problem, when in that coming "Golden Age of Wood" it will no longer be considered a "substitute" material but will come into its own as a primary product.

This optimistic future of the Wood Industries, however, failed to dampen the enthusiasm of the metal, plastic and machine tool groups. Refusing to look ahead to their impending doom, these groups proceeded with the immediate problems of building guns, ordnance

[1]Eli Lilly & Co., Indianapolis, Ind.

plants, airplanes, machine tools and producing the metals, alloys and plastics needed by the Defense Program.

Power and Fuels

By contrast, the fuels and power sessions seemed prosaic, which perhaps accounts for the fact that this group did not get into full swing until the last session. This was devoted to a detailed report of the research work, done at Purdue University over a period of years by Professors Solberg, Hawkins and Potter, on corrosion of unstressed steels and alloys by high temperature steam.

While a number of alloying materials apparently influence the corrosion rate to some extent, the chromium content appears to be the determining factor. Chromium contents of 7 per cent or more give high corrosion resistance at temperatures at least up to 1400 deg. F., while at this temperature the 18-8 steels show practically no corrosion. As the chromium content drops below 7 per cent, and temperatures rise above 1000 deg. F., the corrosion resistance decreases rapidly.

Highest resistances are shown by those alloys which form a thin, tough and tenacious protective coating or scale, lowest resistance by those which form a heavy, porous and brittle scale which keeps peeling off to expose new surfaces. How these scales are influenced by impurities carried over by the steam remains to be determined from actual plant operation under different conditions. That this may well be appreciable was brought out in the discussion. Comparable data indicate that the corrosion problem in air is much less than in steam. Also the tough corrosion problems of the petroleum industry are not as tough as are commonly assumed and appear to fall midway between air and steam.

Superheaters and Slag

Corrosion is, of course, only one superheater problem and William J. Vogel[2] in his paper on the evolution of furnace and superheater design touched many others. Wider application of water walls and use of higher pressure has drastically reduced the steam making a boiler surface, while demand for high temperatures has greatly increased the size of the superheater. Simplicity of design, with high availability, uniform steam temperature and freedom from slag are present day objectives.

[2]Combustion Engineering Co.

Discussion by operating men indicated that slag is still the predominant problem, not so much in itself, but due to its influence on steam temperature regulation demanded by the modern turbine for economy at one extreme and safe operation at the other. With changing loads and the variety of coal that must be burned today the problem is much intensified. Boiler designers expressed confidence in their ability to handle different coals provided the operators did not "expect exactly the same results—for the Lord made the laws of physics."

Discussion also brought out prediction of even higher pressures and temperatures which in time might lead to demands for water wall surfaces which would heat water, evaporate water and superheat steam and change the ratio of these functions as the load changed. Still another prediction was an impending long drawn out fight between proponents of natural and forced circulation. This will undoubtedly be settled only after the results of practical application are available.

The Watts Bar Steam Station of the T.V.A. was described by C. R. Rich[3] and R. T. Mathews[4] (see POWER PLANT ENGINEERING p. 54, October). This station with 900 lb., 900 deg. F., 50,000-kw. units is definitely connected with National Defense largely through the production of aluminum, and will eventually add 200,000-kw. or about 10 per cent of modern steam station capacity to the T.V.A. hydro system.

Under some conditions water and steam do not go so well together and the 1937 flood far above previous flood levels, put the Louisville utilities completely out of service. A. G. Rosenbaum described the flood, principally from the standpoint of the Louisville Gas & Elec. Co. system, in four general parts: the unsuccessful fight to maintain service and cope with the rising water; establishment of partial temporary service; rehabilitation of generating and distribution facilities; and finally the protection against future floods above the 1937 level. (See the description of Paddys Run Station in this issue.)

Industrial By-products

Many industrial processes produce considerable quantities of waste gases or vapors under pressure and sometimes with reasonably

[3]Tennessee Valley Authority.
[4]Charles T. Main, Inc.

Table 1. Complete list of papers presented October 13-15 at the Louisville meeting of the American Society of Mechanical Engineers with headquarters at 29 West 39th St., New York City. Those papers marked with an asterisk (*) were available at the meetings as reprint, preprints or in mimeographed form

Fuels and Power

*White Burley Tobacco—What the Engineer Should Know About Its Production. By Lester S. O'Bannon, Univ. of Ky.

*Evolution of Furnace and Superheater Design. By William J. Vogel, Combustion Engineering Co., Inc.

Development of Drying Process in Switzerland. By Rudolph Bernstein, Switzerland, and Arnold Weisselberg, Cons Engr.

*Drying of Agricultural Products. H. L. Schmidt, Arnold Dryer Co.

*The Watts Bar Steam Power Station of the T.V.A. By George R. Rich, T.V.A. and Ralph T. Mathews, Chas. T. Main, Inc.

*A Method of Estimating the Circulation in Steam-Boiler-Furnace Circuits. By A. A. Markson, C. G. R. Humphreys and T. Ravese, Consolidated Edison Co. of N. Y., Inc.

The 1937 Louisville Flood. By A. G. Rosenbaum, Louisville Gas & Elec. Co.

*Turbines for Power Generation from Industrial-Process Gases. By John Goldsbury and John R. Henderson, General Electric Co.

*Reasons for the High Mortality Rate in Municipal Smoke-Abatement Campaigns. T. A. Marsh, Iron Fireman Mfg. Co.

*Essentials of a Smoke-Abatement Program. By H. K. Kugel, Div. of Smoke Regulation and Boiler Inspection, Washington, D. C.

*Corrosion of Unstressed Steel Specimens and Various Alloys by High-Temperature Steam. By H. L. Solberg, G. A. Hawkins and A. A. Potter, Purdue University.

Metals, Alloys and Plastics

Fundamentals of Design and Performance of Molded Parts. By W. B. Hoey, Bakelite Corp.

Synthetic Rubber, Its Production Capacity and Use. By O. M. Hayden, E. I. du Pont de Nemours & Co., Inc.

*The Role of Induction Heating in War Production. By Frank T. Chestnut, Ajax Electrothermic Corp.

*Manufacture and Processing of Aluminum and Its Alloys. By Paul P. Zeigler, Reynolds Metals Co.

A Survey of Shell Machining with Carbide Tools. By Malcolm F. Judkins, Firth-Sterling Steel Co.

*Industry Aids the Arsenals. By W. D. Bearce, General Electric Co.

Management and Miscellaneous

Problems Connected with the Erection of New Plants. By W. O. Hauck, Indiana Ordnance Works.

*The Wright Aeronautical Plant in Cincinnati. By Russell T. Howe and R. K. Brown, Wright Aeronautical Corp.

*The Engineers' Responsibility for Depreciation. By Frank W. Jackson, American Appraisal Co.

*Depreciation Estimates in Appraisals of Manufacturing Equipment. By P. T. Norton, Va. Polytechnic Inst., and E. L. Grant, Stanford Univ.

Methods of Improving Industrial Hygiene. By James R. Allan, International Harvester Co.

*Air Filters for Airplane-Engine Protection. By Wm. K. Gregory, American Filter Co., Inc.

*A Development in the Manufacture of Ice. By B. F. Kubaugh, Henry Vogt Machine Co.

*The Application of the Girbotol Process to Industry. By B. D. Storrs and R. M. Reed, Girdler Corp.

Wood Industries

*Variation in Shrinking and Swelling of Wood. By A. J. Stamm and W. K. Loughborough, Forest Products Lab. and Univ. of Wis.

*Modern Timber-Construction Methods in Europe. By E. George Stern, Va. Polytechnic Inst.

*Resin Adhesive in Door Constructions. By Tinsley W. Rucker, III., The Mengel Co.

Effect of Resin Treatment and Compression Upon the Properties of Wood. By R. M. Seborg, Forest Products Lab., and A. J. Stamm, Univ. of Wis.

*Urea Treatment of Lumber. By J. F. T. Berliner, E. I. du Pont de Nemours & Co., Inc.

*Progress in Methods of Edge-Gluing Lumber and Veneers. By H. K. von Maltitz, Plycor Co. and Oscar S. Bolling, Mereen-Johnson Mach. Co.

high temperatures. Production of by-product power from these gas turbines was discussed by John Goldsbury[5] and John R. Henderson[5]. The turbines may be operated singly or in tandem with steam turbines so as to take up any irregularity between by-product power production and the load. One application of these machines is in connection with catalytic petroleum refining process; another closely related application is in connection with natural gas.

B. D. Storrs[6] and R. M. Reed[6] also talked about by-product recovery, but in connection with the removal and recovery of such acid gases as H_2S and CO_2 by means of the Girbotol process. This was developed in 1928 for recovering CO_2 from helium bearing natural gas and consists essentially with scrubbing the gases with solutions of organic bases. Since then the process has been used in connection with a wide variety of applications including purification of natural gas, purification of hydrogen, recovery of CO_2 from stack gases, in the production of inert atmospheres, ammonia synthesis and by manufacturers of hydrogenated edible oils.

By-products of another nature, principally the production of stock foods by means of the Arnold internally fired dryer was described by H. L. Schmidt.[7] It has been successfully applied to the commercial drying of alfalfa, soy bean plants, manure, sewage, bagasse, cotton seed, tomatoes and grapefruit waste as well as brewers and distillers grains. Florida which in 10 yr. jumped from No. 20 to No. 2 in the list of beef cattle production (exceeded only by Texas) utilizes many formerly waste products including bagasse, lemon grass and citrus wastes for producing good cattle feed.

Tobacco

Cattle and tourists are important to Florida, but 40 per cent of the farm income in Kentucky is from tobacco, which cured and graded sells at from 5 to 31 ct. per lb. said Lester S. O'Bannon[8] in his paper White Burley Tobacco — What the Engineer Should Know About Its Production. Tobacco offers a small but constant market for coal and coke; for steam sterilization of the ground from 5 to 8 in. deep before planting, and, for temperature regulation during the curing process.

[5]General Electric Co.
[6]The Girdler Corp.
[7]Arnold Dryer Co.
[8]Agricultural Experiment Station, University of Kentucky.

Temperature itself is relatively unimportant and may range from 60 to 95 degrees without affecting the quality. The relative humidity should be kept within a small range per cent for best results and varies with the type, from 65 to 70 per cent in Kentucky to 78-82 per cent in Connecticut. The usual method of humidity control is by means of coke stoves. Discussion brought out the fact that, while the potential market for air conditioning equipment should be considerable, due to the small installations, short season and farm labor, the industry will not stand the investment for real air conditioning and that practically it is a job for the simplest kind of hot air furnace.

A new tube ice machine was described at one of the meetings by B. F. Kubaugh[9]. The freezing unit looks like a vertical shell and tube condenser with the refrigerant on the outside of the tubes and water to be frozen is fed to the top of the tube. In these tubes ice water may be frozen to any desired thickness from a thin sheet to a solid tube. When frozen to the desired thickness it is loosened by warm water and as it drops from the tubes is cut into the desired length by a rotating cutter or if desired broken into small pieces or flakes.

[9]Henry Vogt Machine Co., Inc.

Smoke Abatement

Due to the fact that a proposed local smoke abatement ordinance was snowed under in the municipal election, two papers with a touch of unconscious irony, seemed unusually appropriate. T. A. Marsh[10] discussing the reasons for the high mortality rate in municipal smoke abatement companies cited some reasons as: lack of public sentiment; ineffectual educational campaigns; and lack of political judgment. H. K. Kuge[11] followed this with a paper on the Essentials of a Smoke Abatement Program. After dividing the problem into two parts, what to accomplish and how to accomplish it, he broke each part down into essential subdivisions and told why each should be included in the program.

Space permits mention of only a few of the topics covered at the meeting, but because the program included such a variety of papers of specific interest to special groups at this time a complete list is given in Table I for the convenience of those who may care to obtain copies for closer study.

[10]Iron Fireman Mfg. Co.
[11]Div. of Smoke Reg. & Boiler Inspection, Washington, D. C.

MODERN COOLING TOWERS

During the past 20 yr. great progress has been made in mechanical draft cooling towers largely as the result of stringent requirements of the rapidly growing air conditioning field. The author outlined these changes recently before the A.S.M.E. and this abstract indicates the application of different types of water cooling equipment, summarizes the salient features of the modern mechanical draft tower and gives detailed construction and cost data

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ALL WATER COOLING equipment can be classified under three general headings: spray ponds, atmospheric or natural draft towers (usually of the deck type in larger applications) and mechanical draft towers. Between 1915 and 1920 the spray pond was the system generally in use for large water cooling requirements. This apparatus called for large areas, a factor for consideration if space was costly or limited, and, except where earthen or natural ponds could be used, basins often proved expensive.

Pumping heads ordinarily ranged between 25 and 30 ft. On the credit side, first cost was usually favorable by comparison with other equipment then offered, there was no power requirement for fans, and depreciation was extremely low on systems of proper materials such as cast iron pipe and fittings together with bronze spray nozzles.

A well designed spray pond of 10,000 g.p.m. capacity requires a space about 130 by 400 ft. Additional capacity may be figured at about 4 sq. ft. per gal. Because of spray drift, ground close to such a pond is usually rendered unsuitable for use. A mechanical draft tower for similar service due

to its higher thermal efficiency, now could equal the pond's performance circulating 8000 g.p.m. in a space 60 by 90 ft. and the utility of surrounding areas would not be impaired.

The spray pond is limited in cooling performance and it is impractical to design one for severe cooling conditions such as a close approach to the wet bulb with a relatively long cooling range. A well designed spray pond will approach the wet bulb by an amount approximately equal to the cooling range; that is to say, if the pond must cool water 15 deg. F. the cold water will be 15 deg. F. above the prevailing wet bulb temperature.

This rule of thumb method gives only a rough approximation, but it is not generally feasible to design the larger systems for much better performance unless the water is sprayed a second time, thus doubling the space required, the pumping costs and the investment. In such cases, when concrete basins or louver fences are required the investment becomes excessive.

The atmospheric deck type of tower has been very popular throughout the south and west, being considered quite satisfactory wherever the location offers good exposure to the breeze, particularly in sections where prevailing breezes through the summer are from one general direction. While well suited to many industrial services in open or rural areas, they are not adapted to restricted locations where breeze is limited. Atmospheric deck towers are usually designed with pumping heads of 30 to 40 ft.

Drift moisture nuisance is often considerable and chiefly for this reason they are not practical for locations on downtown building roofs or adjacent to expensive mechanical equipment or buildings in industrial plants. Up to a certain size, first costs compare favorably with mechanical draft, although high pumping requirements and total dependence upon atmospheric caprice, especially wind, are offsetting factors.

The mechanical draft tower for years was considered only for cooling requirements where space limitations or lack of dependable breeze prohibited spray ponds or atmospheric deck type towers. They were very expensive, heavy and unsightly. Objectionable drift moisture was characteristic. Operating costs were high, chiefly because of fan power. Maintenance and depreciation both were abnormal by modern standards.

It may be said that the rapid growth of air conditioning, principally, led water cooling equipment manufacturers to design a new and better product because practically none of the equipment available at the start of this growth was satisfactory to the new and stiffer requirements. Most towers in air conditioning service are located on roofs in populous districts so that space is restricted, the weight which can be supported is frequently limited and noise and drift moisture are usually highly objectionable. It is further necessary to obtain the maximum cooling efficiency during the hottest of summer weather and appearance is of great importance.

Of recent years the widespread use of air conditioning in metropolitan districts has created a demand not only for more efficient cooling towers, but for designs that fit in well with the architectural treatment and meet diverse building code requirements

Mechanical draft towers were obviously indicated for such service and tower manufacturers began improving and simplifying their designs and details to reduce weight as well as cost and power requirements. Today they are the most generally accepted means of water cooling for nearly all classes of work. It is possible to design mechanical draft towers for almost any desired approach to the wet bulb and thus obtain longer cooling ranges and closer approaches under all conditions than is practical with any other style of cooling equipment.

General dimensions have changed materially, area being slightly increased for a given cooling requirement, and frame height greatly reduced. Such changes permitted reduced water loads per square foot of area, smaller frame members and less structural bracing to withstand maximum wind conditions. Reduced height gave reduced pumping head and increased area resulted in reduced draft loss. From total heights of between 30 and 40 ft., the trend has been downward to between 20 and 26 ft. for present day practice. The practical loadings of towers, in gallons of water per square foot of effective tower area, will usually come within a range of 2 to 6 gal.

Best modern practice is to double case the tower with an air space provided between the two casings. Some leakage may still occur on the single inner casing, but it will drain downward to the water basin and the outer casing remains tight, free from leaks, and presents a smooth, stainless, pleasing appearance externally. Practically no free moisture escapes from a modern tower. Drift loss guarantees not to exceed 0.1 or 0.2 of 1 per cent are usual and a loss this low is so small as to be negligible either as a cost factor, as a rust hazard to nearby machinery or as a public nuisance.

In larger cooling towers there has been but little change in total weight. In smaller cooling towers, relatively high and narrow, important weight reduction has been accomplished. Water inlet, piping, anchor base plates, structural plates and other items used in tower construction are now often made of cast iron instead of

steel as was common practice in earlier designs.

Present design results in draft losses of 0.35 to 0.45 in. of water instead of 0.5 to 0.6 in. formerly typical. Practice in early mechanical draft towers was about 275 to 300 ft. per min. upward air velocity through the decking or "fill" area, whereas today, with more open fill and shorter travel, velocities of 325 to 350 ft. per minute are now commonly used for design purposes. While these higher velocities with shorter travel actually result in a reduced saturation of the outgoing air it has been found more economical to circulate the larger volume of air at lower draft loss.

The propeller-type wheel with adjustable pitch is now used by nearly all mechanical draft tower manufacturers, tip speeds averaging 9000 to 10,000 ft. per min. and noise levels so low as to be generally accepted without special provision. Early mechanical draft towers in the larger sizes used fans of 8 to 10 ft. max. diam. These sizes gradually increased to 11 and 12 ft. which are a practical maximum for forced draft. Recent induced draft design permits use of larger fans and diameters of 15 to 16 ft. are now common. There are induced draft cooling towers operating in Europe with propeller-type fans 20 to 24 ft. in diam. Larger fans mean fewer starters, less electrical wiring and, on the unusually large towers, simplify operation considerably.

Many improvements in speed reducing equipment, including Tex-rope drives, gear motors and enclosed right-angle gear boxes have been developed for cooling tower service. The most satisfactory designs now use a right-angle gear box with the fan wheel mounted upon the slow speed shaft and the high speed drive shaft sufficiently long to permit locating the motor outside the fan ring and air stream. Splashproof motors, a development of the past few years, are entirely satisfactory for cooling tower fan operation when so located whereas, when located in the air stream, fully enclosed motors are desirable. For industrial towers operating throughout the year, two-speed motors are recommended to give adequate operating flexibility and low total power consumption.

Modern towers with their low height do not lend themselves well to winter operation without using fans. For this reason the modern tower with its high speed, light weight air-foil fans must be designed to operate without water accumulating upon the fan housings or wheels, thus assuring that ice will not form. Fans do not ice up in the induced draft type of mechanical draft tower.

It has now become generally necessary that manufacturers build towers to withstand not less than 25 and usually 30 lb. per sq. ft. wind pressure, the minimum accepted standards of leading insurance companies, standardized city building codes, etc. Larger cities require that such structures be fire-proof, thus eliminating towers of wood construction. Steel towers usually cost 30 to 50 per cent more than similar towers of wood.

A common difficulty experienced with forced draft towers, especially in the larger multiple fan installations, is the tendency of the outgoing air, leaving the tower at low velocity, to travel horizontally and be drawn downward in the fan currents to reenter the tower and thus reduce cooling efficiency because of the hot, saturated condition of this used air. Such recirculation frequently nullifies 12 to 15 per cent of the tower capacity, which means that either a larger tower than would otherwise be necessary must be used or the cooling results may prove unsatisfactory.

Where such conditions are likely to occur it is well to use towers of the induced draft type from which air discharges vertically at relatively high velocity or to extend the tower casing upward to such height as to combat any probability of this objectionable cycle taking place. This explains the marked and rapid trend of induced draft toward supplanting forced draft for large multiple fan installations.

Probably the more important points brought forth in this paper can be summarized best by the attached tabulation which compares significant data on three representative sizes of towers for the years 1925, 1932 and 1941. The information given is for towers completely installed upon concrete foundations provided by others. The figures do not include the cost of electric wiring, starters, foundation or water piping beyond the tower connection.

A brief study of the table will indicate clearly that operating costs are reducing constantly, with comparable reductions in fan horsepower and water pumping head, while at the same time the actual delivered and erected cost for the more improved product is also declining. Appearance is better, drift loss has been eliminated and the number of fans required is going down steadily. This tabulation further indicates why today mechanical draft towers are gaining preference over atmospheric towers or spray ponds.

For in these two latter types little improvements or modernization has taken place and their relative cost has actually risen due to increased labor and material costs which also affect mechanical draft equipment proportionately, but have been offset by aggressive improvement, simplification and closer adaptation to the specific requirements of each application, developing every opportunity for wise reductions in costs of production and operation.

Table of comparisons showing progressive improvement and declining costs of mechanical draft cooling towers

Size	1000 Gallons			5000 Gallons			20,000 Gallons		
Year	1925	1932	1941	1925	1932	1941	1925	1932	1941
Dimensions in ft.									
Width & Length	18x24	19x24	20x24	22x96	30x72	30x80	36x220	26x240	40x240
Height	38	36	24	40	36	26	40	36	26
Effective area in sq. ft.	432	456	480	2112	2160	2400	8420	8640	9600
Fans, Number	2	2	1	6	6	4	22	24	10
Size, ft. diam.	9	9	11	11	11	13	12	11	16
B.hp., each	14.25	11.3	19.03	28.4	19.15	24.0	30.05	19.15	38.4
B.hp., total	28.50	22.6	19.03	170.4	114.9	96.0	671.0	459.6	384.0
Weights, Dry in lb.	57,000	48,000	40,000	280,000	260,000	240,000	960,000	940,000	900,000
Water pumping head in ft.	25	25	20	27	27	20	28	28	20
Price Del. & Erected	$6,000	$5,500	$5,300	$22,000	$20,000	$19,000	$78,000	$71,000	$67,000

LIKE A BOILER EXPLOSION?

Certainly not! The boss can't stand loud noises, the doctor gets peevish when his pinochle game is interrupted and the OPM frowns upon delays in production. Seriously though, boiler explosions are preventable. Boiler manufacturers have eliminated hazardous design features which characterized many early boilers. They have no control, however, over hazards introduced by careless operation, dangerous settings and improper water treatment. This is the engineer's job. To help the engineer, the author draws upon a background of many years practical experience, points out the most likely points of danger or weakness, methods of detecting cracks, leaks and corrosion areas, gives specific recommendations for safe settings and many pointers on boiler maintenance

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MODERN BOILERS are notably free from material defects and design features, which through experience have been shown to be a possible source of trouble, have been eliminated. All boilers are, however, subjected to rigorous operating conditions, often under extremely unfavorable conditions, with poor settings, inadequate maintenance and questionable boiler water treatment so that corrosion is always a potential hazard.

Again many boilers in operation today have seen many years of service and often have design features which are no longer permitted under the A.S.M.E. boiler code so that constant and careful inspection is a prerequisite for safe operation.

For instance head cracks in old boilers should be watched for carefully. Pre-A. S. M. E. bumped head design, and the design permitted by the earlier A. S. M. E. formulae, permitted the use of heads having a large major radius and a sharp knuckle at the turn of the flange. The material was somewhat lighter than would be permitted by modern formulae for the same pressure. Heads of this type frequently crack in the knuckle, as shown by Fig. 1.

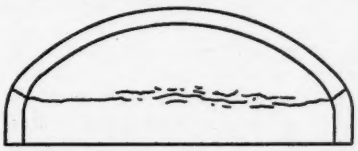

Fig. 1. The groove, which is invariably the indication of a head crack, may appear as a clean straight line and be easily mistaken for a die mark, but it more frequently presents an interrupted ragged appearance usually with short shallow cracks on each side

Cracks may present a continuous, unbroken line and be mistaken for die marks which developed in the original fabrication of the head, although they more frequently present a broken, ragged appearance. Cracks of this type may be present in blind heads, although it is our experience that they are more frequently found in heads having a manhole opening. This is probably because of stress concentrations and the flexture which occurs in heads of this design. Head cracks are not infrequently found in H.r.t. boilers.

There are several methods which can be used in searching a suspected crack of this type. These are illustrated in Fig. 2 and explained more in detail below.

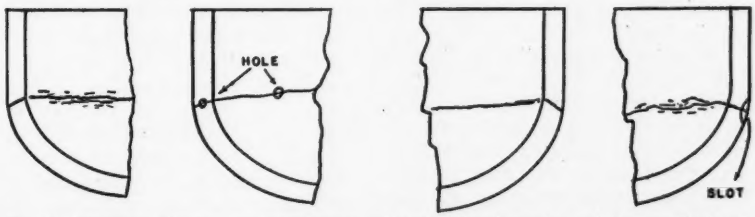

Fig. 2. Diagrams showing the appearance of typical head cracks and four methods of detecting them. These methods are described in greater detail in the text

Method 1. Clean the suspected area with a solution of hydrochloric acid, examine with a lens

Method 2. Drill ½ in. hole at center of groove. Hole can then be plugged with a solid plug.

Method 3. Heat suspected area with an acetylene torch. After cooling, the crack will open up

Method 4. Slot outside of knuckle with a cape chisel a depth of quarter the head thickness

Method 1. The scale should be removed thoroughly and the plate cleaned with a commercial solution of hydrochloric acid, then examined with a strong lens. If the crack is of any depth the acid will work its way in and a line of small bubbles will form along the line of the crack.

Method 2. A hole about ½ in. in diameter should be drilled through the center of the groove which is the usual indication of a crack. A sharp drill should be used which will produce a smooth, clean hole. By looking down the hole, using a good light and a strong lens, the crack will be

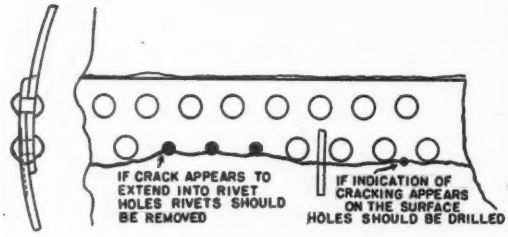
IF CRACK APPEARS TO EXTEND INTO RIVET HOLES RIVETS SHOULD BE REMOVED
IF INDICATION OF CRACKING APPEARS ON THE SURFACE HOLES SHOULD BE DRILLED

Fig. 3. Diagram showing the appearance of typical lap seam cracks. If leakage develops at the calking edge of a lap seam and the seam will not stay tight when calked a crack should be suspected. If there are no indications of cracking on the surface the plate should be slotted and if necessary a hydrostatic and hammer test applied

easily seen if one exists. The hole may be drilled entirely through if desired. It should later be plugged with a solid plug.

Method 3. Heat the cracked area with an acetylene torch, using a neutral flame so as to slowly bring the plate to a dull red heat. If a crack exists the flame will work down and be refracted so as to show clearly while the plate is being heated. After the plate has cooled off the crack will, as a rule, open up so that it can be very easily seen.

Method 4. Cut a radial slot with a cape chisel on the outside of the knuckle to a depth of about 25 per cent of the head thickness. If the crack is not picked up at this depth the boiler is subjected to a hydrostatic and hammer test with the idea of producing leakage through the slotted material in the event that there is a crack working through from the inside of the head.

Cracks occasionally develop at the turn of the flange in box header boilers. The appearance of such cracks is similar to those already described for head cracks and the same methods of searching suspected areas should be used.

Lap Seam Cracks

Indications of leakage must always be thoroughly investigated. If such leakage is at the calking edge of a lap riveted longitudinal seam it may be evidence that a lap seam crack is present. Cracks of this type have been responsible for numerous serious accidents. As a rule these cracks extend along the edge of the rivet heads, although they are occasionally found running from rivet hole to rivet hole, and sometimes at the edge of the plate lap particularly if the seam has been badly calked. The reason for the development of a lap seam crack is well known and need not be considered in detail here.

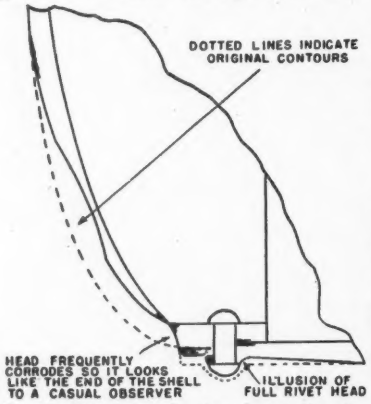
DOTTED LINES INDICATE ORIGINAL CONTOURS
HEAD FREQUENTLY CORRODES SO IT LOOKS LIKE THE END OF THE SHELL TO A CASUAL OBSERVER
ILLUSION OF FULL RIVET HEAD

Fig. 4. This type of external corrosion is frequently found in blind heads concealed in brickwork

Old lap seam boilers should always be suspected of this defect. Cracks as a rule start at the contact surfaces of the plate and work out. They are particularly dangerous for this reason because by the time they reach the outer surface and reveal themselves by the presence of leakage, the boiler is probably in a seriously weakened condition.

The method of finding an internal lap seam crack is to first remove the brickwork so that the longitudinal seam will be fully accessible for complete examination. If there are faint indications of cracking on the surface of the plate the methods of test already outlined for head cracks should be used. If the crack appears to run through rivet holes, remove the rivets, clean the holes with acid, and examine. If cracking does not show on the surface, slot the plate circumferentially between the rivet holes with a cape chisel to a depth of about 25 per cent of the original thickness.

If the crack is of any noticeable width and depth it will probably be revealed at the bottom of the slot. If the crack is not wide and does not show itself, the boiler should be subjected to a hydrostatic and hammer test. A sledge hammer of about 6 lb. weight should be used and the seam hammer tested on both sides of the riveted area. Rapid hammer blows should be used so as to set up a vibrating effect.

If a crack is present, even though it has not yet reached the bottom of the slot, it will probably break through and develop leakage under this test. Practically all states having boiler legislation prohibit the repair of a boiler which is found to have a lap seam crack, the reason being that the material in boilers which are cracked in this way must always be suspected of serious defects. In making this statement I do not wish to overlook the fact that the design and fabrication method are largely responsible for the development of lap seam cracks.

Surfaces Concealed in Brickwork

Practically all stationary boilers are set in brickwork and although some modern designs permit examination of areas subject to external corrosion, the older designs did not provide for such an inspection. A number of years back it was common practice to set bent tube boilers in pairs with a common party wall between them. The blind heads of the drum were set in this wall and were inaccessible for examination.

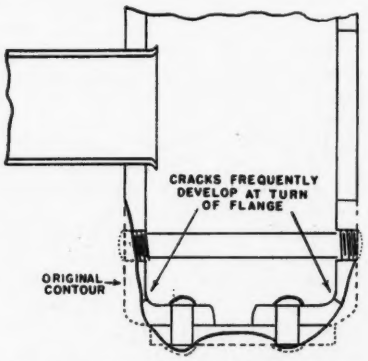

Fig. 5. Section of a box header showing typical external corrosion

There is a tendency for soot and ashes, etc., to collect in the space between the brickwork and the external surfaces of the blind head of the lower drum. In combination with water these deposits will release sulphuric acid and set up rapid severe corrosion. It is necessary that provisions for inspection of concealed heads be made carefully and the brickwork should be removed periodically so as to permit a thorough examination of the external surfaces of the heads.

Occasionally corrosion will develop in such a way that the extent of the deterioration will not be fully revealed. In such cases

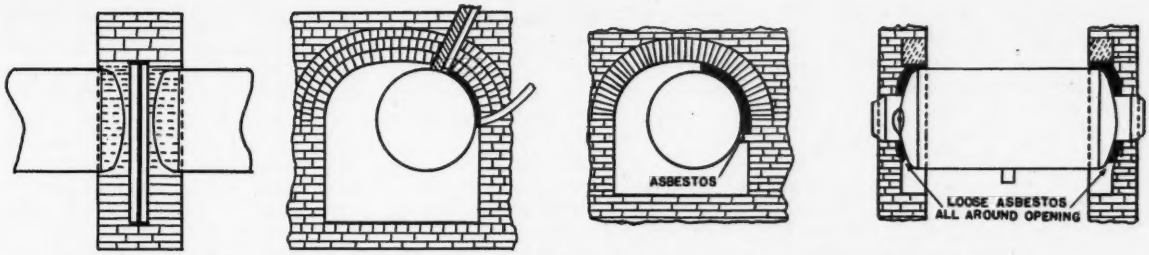

Fig. 6. Methods of providing for easy inspection of blind heads. These are always a source of potential danger

test holes must be drilled at the bottom of the knuckle. A hole should be drilled on the bottom center line and one on each side at a circumferential distance of from 8 to 10 in. away. As a rule external corrosion of this type occurs at the bottom of the head of the lower drum or on the upper drums. If there is reason to suspect that such corrosion exists in the heads of the upper drums, the brickwork should also be removed so as to permit a thorough examination.

Very frequently serious external corrosion develops on the section of the lower drum behind the bridge wall and on the external surface of the shell between the tube holes in the lower drum, in bent tube boilers. The presence of such corrosion must always be suspected in boilers of any appreciable age and if necessary sufficient brickwork should be removed to permit an examination of the suspected areas.

This also applies to the upper parts of the shell plates of H.r.t. boilers, to that part of the shell concealed by the front wall of the setting and also to the upper drums of water tube boilers which are covered with brickwork. The presence of leaking joints in overhead steam lines, leaking packing glands of stop valves or shut-off valves in feed lines, etc., will quickly saturate the brickwork and cause serious corrosion of the plate underneath. Rain leakage through defective roofs will have the same effect.

Box header boilers are frequently set with the bottom of the headers concealed in brickwork. On account of leakage at the hand-hole openings serious external corrosion frequently develops under the brickwork, Fig. 6 being typical. We have very frequent record of wrapper sheets corroding through to the point where leakage develops, although such corrosion had not always been detected at the internal inspection. The inspection of boilers of this type should include a removal of the brickwork at the bottom of the box headers on regular schedule. We suggest that the requirements for the inspection of blind heads be followed in this regard.

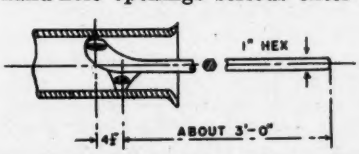

Fig. 7. Type of pinch bar useful in testing tubes for external corrosion in locations which cannot be seen

In sinuous header boilers external corrosion will sometimes develop between the headers. The asbestos filling should be removed occasionally so that an inspection can be made of this area. Both sinuous header and box header boilers are, of course, subject to external corrosion because of leakage at the handhole plates. It is not a difficult matter to detect such corrosion and this condition need not be particularly emphasized.

Bags in H. R. T. Boilers

Bags in H.r.t. boilers are invariably caused by scale or oil. As a rule a bag brought about by overheating resulting from scale deposits is comparatively short, whereas bags caused by oil are usually long, in many cases extending to full length of the course and in some cases extending the full length of the boiler.

Very frequently, because of changes in water conditions or the use of a different water treatment or compound, old scale deposits on the tubes or upper shell plates and heads will be loosened quickly and will fall on top of the lower shell. If the blow-off opening is clogged as usually happens and the boiler is not taken out of service for cleaning, the lower shell plate will become overheated and bag.

In order to prevent occurrences of this nature a very high standard of cleanliness should be maintained. If a boiler shows any tendency to form excessive scale a water treatment should be recommended. While a moderately heavy deposit of adhering scale on the tubes and upper parts of the shell plates may not cause trouble, there is always the possibility of the scale loosening. Heavy deposits of hard scale on tubes can in most cases be removed by the use of a vibrating tube cleaner (rattler). If the scale is not hard the boiling out process, using a strong solution of caustic soda and soda ash, is usually effective. In some cases it may be advisable in removing a hard scale to use 4 or 5 qt. of kerosene. If this is used, however, the boiler should again be submitted to the boiling out process, using only caustic soda and soda ash, before it is returned to service.

Effects of oil in an H.r.t. boiler can be serious. Overheating resulting in damage beyond repair has resulted from oil being carried in with the feedwater or being intentionally placed in the boiler as a preventative of corrosion. While a small quantity of oil on the upper plate surfaces or tubes may not be dangerous at the moment, the fact that oil is being carried into the boiler is a serious hazard and the source of such deposits should be investigated and eliminated.

If there are any indications of oil on the lower parts of the shell plates of an H.r.t. boiler the boiler should by all means be held out of service until it has been thoroughly cleaned.

Tube Failures

Failures of tubes in water tube boilers are a frequent source of loss. Most of such failures are caused by overheating on account of scale deposits. Because of this it is necessary to use good judgment in regard to different types of scale. A comparatively heavy deposit of soft scale in the tubes in the last pass might be perfectly harmless whereas less

than 1/32 in. of hard silica scale in the tubes subjected to radiant heat would be the cause of serious overheating in a boiler operated at a high rating.

Steam binding or faulty circulation in boilers operated at high ratings is a not infrequent source of failure. In such cases the remedy is a job for the manufacturer and may require a change of design or insertion of nozzles, to increase the velocity through the tube, or cores to throw water against the wall of the tube.

Some cast-iron headers are arranged vertically and the inclination is given to the tubes by a series of steps with raised bosses at each tube hole. These bosses are counterbored for about half way through to a diameter slightly larger than the tube. The recess formed in this way collects soot and ash, and if there is any leakage from the tube end the soot and moisture may combine to release acid. Ends of such tubes should first be examined from the furnace and from the top of the tube bank, using a flashlight to search the rows diagonally. Indications of even slight leakage will be easily observed by the encrusted solids around the tube ends. Tubes which show signs of leakage or are otherwise questionable should be examined through the handhole openings in the headers and tested by a pinch bar of a type indicated in Fig. 7.

Nipples connecting the bottom of the headers to the mud drum are subject to corrosion and must be carefully examined. As a rule dirt and rust scale will accumulate around the mud drum nipples. This must be thoroughly removed to permit a proper inspection. The mud drum is frequently subject to external corrosion and no inspection should be considered complete unless the mud drum is carefully examined and hammer tested. All rust scale and dirt should be removed to permit a thorough examination.

Steam cutting and external corrosion caused by improperly located soot blowers is an occasional cause of tube failure. Pitting progressing through the wall of the tube and causing external corrosion and thinning of the metal also causes some failures. The remedies for these conditions are simple, but locating and correcting the defects before trouble occurs is the job of a good boiler inspector.

ORSAT AND MOL

BY HERBERT S. KIMBALL
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TO VERIFY the flue gas analysis by Orsat determination, the molal system, as applied to calculations, offers a simple and satisfactory method. For this it is necessary to have the ultimate analysis of the fuel, and for this study a coal has been chosen. The unburned carbon may be calculated from the Orsat analysis, with the aid of the ultimate molal analysis of the coal, but, as a matter of check, any physical examination concerning the amount of combustible in the refuse and flue gas will be of help. A carbon loss affects the flue gas analysis and of course the heat balance.

If the confining liquid of the Orsat apparatus is mercury, very accurate results may be obtained and from this the burned carbon may be correctly calculated. With water as the confining liquid, however, some of the gas, especially the CO_2, is likely to be absorbed, thus leading to a low calculated value of the burned carbon. As an example, take the Orsat result as given in Table II. This, it will be seen, represents excellent combustion, with 14.68 per cent CO_2 in the flue gas, indicating that the carbon burned is 77.88 per cent of the weight of the coal. If, owing to absorption, the Orsat reads only 14.32 per cent CO_2 (the O_2 as before), the carbon burned is calculated as 63.31 per cent of the coal. If still a greater error is made (the O_2, as before, at 4.40 per cent), so the Orsat gives only 13.90 per cent CO_2, or a larger loss, the carbon burned is but 51.61 per cent of the coal.

A mol of any perfect gas has a volume of 359 cu. ft. at a temperature of 32 deg. F. and at the normal atmospheric pressure of 29.92 in. of mercury; and weighs its molecular weight (M.W.) expressed in pounds. A mol of gas at a higher temperature than 32 deg. F., and at normal pressure, while having an increased volume, will still weigh the same as it did at 32 deg. F.

Table I gives the analysis of coal, "as received," in terms of per cent by weight. In addition, the molal values of the components have been calculated, by dividing the percentage of each component by its M.W., as given in the table. It might be noted that, in these calculations, superfluous figures are omitted, but the last figure retained is increased by one if the first figure omitted is greater than five. In some cases significant figures have been carried out to five places of decimals.

Table II was prepared from the Orsat analysis in conjunction with Table I, using the accepted ratio of O_2 to N_2 (20.9 to 79.1 by volume) in dry air. The three equations in Item 1 enable us to determine the mol ratio between C, S, and H_2 and the O_2 required to produce CO_2, SO_2 and H_2O, respectively. It will be noted in the Orsat results that the percentage

Table I. Analysis of the Coal, as Received

Component	Ultimate Analysis, % by Weight	M.W.	Mols per 100 lb. of Coal: Totals	S	H_2	C	N_2	O_2
S	0.96	32	0.0300	0.0300				
H_2	4.26	2	2.1300		2.1300			
C	78.14	12	6.5116			6.5116		
N_2	1.32	28	0.0471				0.0471	
O_2	3.20	32	0.1000					0.1000
Ash	8.28							
H_2O	3.84*	18	0.2133		0.2133			0.1066
Totals	100.00			0.0300	2.3433	6.5116	0.0471	0.2066

*From the molal equation: 1 mol of H_2 + ½ mol of O_2 = 1 mol of H_2O. It is clear that if there is 0.2133 mol of H_2O, there will be that number of mols of H_2, but only ½ as many of O_2 mols.

Table II. Calculated Molal Analysis of the Flue Gas, from the Orsat Determination

Mols per 100 lb. of Coal, "as received."

	Items	Explanations	DRY GAS: X = Mols of CO_2 — Totals (mols)	Substituting — Totals, Mols	Substituting — Mols	Per Cent by Orsat
1	O_2 required for:					
	(a) C to CO_2	1 mol C + 1 mol O_2 = 1 mol CO_2	[a] X	6.4898		
	(b) S to SO_2	1 mol S + 1 mol O_2 = 1 mol SO_2	0.0300 [b]	0.0300		
	(c) H_2 to H_2O	1 mol H_2 + ½ mol O_2 = 1 mol H_2O	1.1717 [c]	1.1717		
	(d) Total,	Total O_2 required,	1.2017 + X	7.6915		
2	O_2 in fuel,	From Table I (to be deducted).	0.2066	0.2066		
3	O_2 in required air,	Item 1—Item 2.	0.9951 + 1.0000 X	7.4849		
4	Excess O_2, (25.98%),	See below for calculation.	0.00895 + 0.2983 X	1.9449	1.9449	4.40
5	Total O_2 in air,	Sum of Items 3 and 4.	1.00405 + 1.2983 X	9.4298		
6	Total air supplied,	Item 5/0.209 or Item 7/0.791		45.1187		
7	N_2 in air supplied,	Item 5 × 79.1/20.9	3.8000 + 4.9137 X	35.6889		
8	N_2 in fuel,	From Table I (to be added).	0.0471 +	0.0471		
9	N_2 in gas,	Sum of Items 7 and 8.	3.8471 + 4.9137 X	35.7360	35.7360	80.85
10	CO_2 in gas,	1 mol C + 1 mol O_2 = 1 mol CO_2	X	6.4898	6.4898	14.75[e]
11	SO_2 in gas,	From Table I; and see Item 1b.	0.0300	0.0300	0.0300	
12	H_2O vapor,	To be used when computing wet gas.				
13	Total dry gas,	Mols of dry gas equal sum of mols of CO_2 and SO_2 divided by percentage expressed as a decimal. See below for equation.	$\frac{X + 0.0300}{0.1475}$		44.2007	100.00
14	Total wet gas,	Not calculated in this problem.				

[a]: according to equation, mols of O_2 same as mols of CO_2.
[b]: mols of S from Table I; equation shows same number of mols of O_2 as of S.
[c]: from mols of H_2 in Table I, take ½ of number for mols of O_2 to form H_2O.
[e]: or, in proportion to mols, CO_2 = 14.68 per cent and SO_2 = 0.07 per cent.

Item 4: Item 13 $\times$ 0.044 $= \frac{X + 0.0300}{0.1475} \times 0.044 = \frac{0.044\,X + 0.00132}{0.1475} = 0.2983\,X + 0.00895$

Item 13: The total dry gas is made up with the components, as follows:

Item 4: 0.00895 + 0.2983 X
Item 9: 3.8471 + 4.9137 X
Item 10: 1.0000 X
Item 11: 0.0300

Item 13: $3.88605 + 6.2120\,X = \frac{X + 0.0300}{0.1475}$. This fraction is the expression for Item 13, as given in the table.

Solving the equation: $0.5732 + 0.9163\,X = X + 0.0300$, or, $X = 6.4898$.

of CO_2 also includes that of the SO_2. Such has to be the case, because the reagent that absorbs the CO_2 absorbs the SO_2 as well.

In preparing a table of this kind begin with Item 1 in the algebraic column, letting X = the number of mols of CO_2 per 100 lb. of coal. An expression for Item 13, which is needed to calculate Item 4, is given in this same column and in the column "Explanations" where reference is made for each step. The value of X is solved at the bottom of the table, and when substitutions are properly made, the various molal values are obtained. To check the total number of mols of dry gas (Item 13, 44.2007 per 100 lb. of coal) calculate the percentage of each component from the molal values and this should agree with the Orsat determinations to prove the calculations correct.

Item 6 is obtained by two methods, and as a further proof, its value should be the sum of Items 5 and 7. The percentage of excess O_2 (excess air) as given by Item 4 (25.98 per cent) is determined by dividing Item 4 by Item 3 and multiplying by 100. The molal values of the dry gas may be used to calculate the heat lost in the dry gas, when preparing the heat balance. This is conveniently done by heat capacity charts, given in terms of B.t.u. per mol of gas at various temperatures.

As there are 6.4898 mols of CO_2 there are also that number of mols of carbon that are burned per 100 lb. of coal; and as the coal contains 6.5115 mols of carbon, there is 0.0218 mol of carbon that is not burned. Then, 0.0218 × 12 = 0.26 per cent by weight of the coal represents the unburned carbon, which should be compared with the result found by physical means. The carbon burned amounts to 6.4898 × 12 = 77.88 per cent of the weight of the coal.

X-ray for weld inspection has advanced from 200,000 v. used in 1929 by Babcock & Wilcox Co. for thicknesses up to 2 in. through 300,000 v. in 1932 and 400,000 v. in 1935, the last requiring 3½ hr. per ft. of weld in 4½-in. plate, until the latest machine of General Electric X-Ray Corp. uses 1,000,000 v. for 8-in. plate and requires only 3 min. per ft. of weld. The equipment traverses above a pit 64 ft. long, rays being directed downward and carriage is adjustable, vertically, horizontally and laterally. Controls are in a separate room, providing 36 in. of concrete wall as protection to the operator.

ALGONA DIESEL PLANT Moves to New Site

BY GLENN C. BOYER
Associate Engineer
Burns & McDonnell Engineering Co.

After a vigorous sale of electric appliances in the community, the electric load on Algona's municipal Diesel plant demanded an expansion of generating facilities which could not be accommodated on the combination power plant-city hall site which had served the purpose since 1898. One or the other had to give way. Who won? The plant moved into a brand new building on a new site with every modern convenience and room to expand. In the long run the city is bound to profit by the new move

THERE comes a time in the history of every power plant when it is necessary to move it, junk it, or perform a major operation in the matter of rehabilitation. Too often the tendency, particularly in the small station, is to attempt to patch up in the hope that the fatal day, necessitating a major change, will not arrive.

Algona, Iowa, was faced with this major decision 2 yr. ago. After considering all possibilities for rehabilitating its plant which had been operating since 1898, the city decided that the only answer to the problem was to move. In moving it acquired one of the outstanding Diesel electric generating stations in the middle west.

A thorough study of the entire problem pertaining to the power plant was made, and the decision was to move it. The study showed that an expenditure of approximately $170,000 would be required to rehabilitate the existing plant and add the necessary generating capacity, while an entirely new station could be constructed, and equipment moved from the old plant for approximately $250,000.

The new station was completed, and the 1500-hp. unit purchased as part of the expansion program, was tested and pronounced ready for regular operation in September of this year. Three units, now installed in the old plant, will be moved shortly and the center of operations for the electric department will then be in the new plant. Space is available in the plant for a fifth engine-generator.

Cantilever Floor Construction

There are a number of features which make this plant unusual. Most striking of all is the absence of beams and columns normally required for supporting the operating floor in the engine room. Through the use of cantilever floor construction in this room, all of this was eliminated, and the space in the engine room basement made available for more effective use. Conventional roof trusses were also done away with in the engine room by employing rigid frame construction for the structural steel building framework.

The plant was designed with consideration given to convenience and ease of operation. A 15-ton single-motor operated traveling crane was installed in the engine room, while a 3-ton chain block and trolley operating on a monorail was installed in the plant shop on the south end of the engine room. Thus any piece of equipment which must be taken to the shop for repairs can be handled with a minimum of effort and time. Lubricating oil coolers installed with the various engines were located in vertical positions in the basement with hatchways over them so tube bundles could be removed and replaced with the traveling crane.

Intake air cleaners and mufflers are readily accessible by means of a stairway from inside of the building. The intake air filters are of the cycoil type. Tests of pressure drop through the air filter and most of the connecting air piping showed a pressure drop of approximately 5 in. of water during the various load tests on the engine. Mufflers were manufactured by the acoustical division of the Burgess Battery Company.

Engine Room Arrangement

The engine room proper is 51 by 96 ft. in size. Along the front, or east side, is a low projecting addition which provides housing for the switchgear, superintendent's office, and wash room. On the south is an addition for a plant shop. In the southwest corner of the engine room are large double doors provided with an exterior ramp so that trucks can be backed into the building and equipment unloaded with the help of the traveling crane. Along the entire west side of the engine room is an addition which is used for an office for the plant operating staff, small-parts store room, and space for air compressors and oil con-

Fig. 1. In the Algona plant at the present time is this 1500-hp. Fulton Diesel. Three other engines will be moved from the old plant and installed on foundation now provided. Space is provided for another new unit

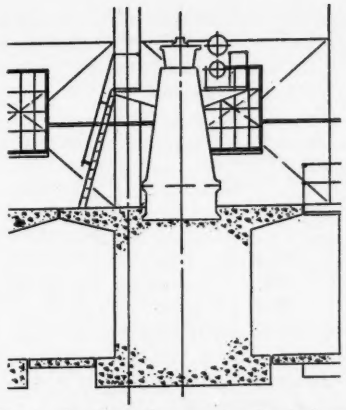

Fig. 2. Cantilever floor construction is shown by this typical section

ditioning equipment. The basement space under this addition to the west houses the raw and jacket water pumps. Basement space underneath the switchboard and plant entrance lobby is used for a transformer room and a station battery room. Basement space underneath the shop is designed as storage space for heavy maintenance parts for the engines and their accessory equipment.

Starting air tanks for the plant are located in the space between two of the engine foundations. A common starting air header is provided for the entire plant, and each starting air tank is valved off so that any one tank, or any group of tanks, can be used.

The design of the entire station was arranged for the greatest flexibility and operating convenience. Due to the design of the operating floor, it will be possible to remove any engine and its foundation and substitute an engine as large as 2000-hp. in its place without disturbing any other part of the building. Additions can be made to the cooling tower, fuel oil storage tanks, or to the building proper if necessary without interfering in any way with the operation of the existing plant.

Cooling Water System

The ability to make additions or changes results from the care which was taken to insure operating flexibility and ease of maintenance of the plant and equipment installed as part of the original construction. This flexibility is well illustrated by the design of the cooling water system for the engines.

Cooling of the engine jackets and lubricating oil is effected by an induced draft type of tower having spray coils installed in the base of the tower. The heat removal capacity of the tower is 10,000,000 B.t.u. per hr. This unit is really two towers, each having a capacity of 5,000,000 B.t.u. per hr. The raw water basin is divided so that either half can be taken out of service for cleaning, maintenance, or repairs as the occasion may require. The spray coils are likewise divided into two sections, either of which can be taken out of service.

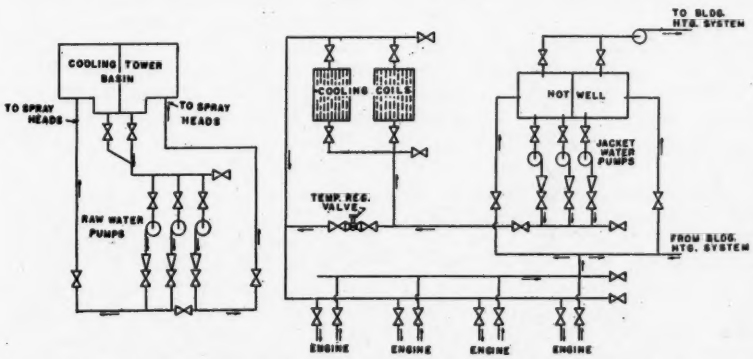

Fig. 3. Diagram of cooling systems—raw water left, jacket water right

Raw water for cooling is taken from the tower basin into end-suction type centrifugal pumps and discharged into the tower distributing headers, or bypassed into the lower tower bypass system as weather conditions may require. The induced draft fans are equipped with two-speed motors. By the manipulation of the tower bypass valves on the raw water as well as the induced draft fan speed, any cooling requirements can be met.

Jacket cooling water is stored in a sump at the northwest corner of the building. The jacket water pumps take suction from this sump and discharge into lines leading to the spray coils. From the spray coils, the jacket water goes to a cold-water header in the basement which connects to the cooling water inlet of each engine. After the water passes through an engine it is returned to a second, or hot-water, header which discharges into the jacket water sump.

Six cooling water pumps are used, three of them for the raw water system, and three for the soft water side. The raw water pump consists of a 400 g.p.m. and two 850 g.p.m. units operating at 35 ft. head with a shutoff head of 45 ft. The jacket water pumps consist of a 450 g.p.m. and two 825 g.p.m. units operating at 65 ft. head with a shutoff head of 85 ft. All pumps are of the end suction, single stage type, and each pump is provided with a rubber expansion joint on the inlet side to facilitate dismantling of inlet piping for inspection and maintenance of the pump.

Provisions are made for maintaining a constant outlet water temperature from the engines through the use of a temperature-operated bypass valve which shunts a part of the cooling water around the spray coils in the cooling tower.

Heating of the building is done by passing the hot water from the engine jackets, maintained at 130 deg. F., through eight unit heaters placed in various parts of the building and in the two offices and washroom. The unit heaters in the superintendent's and plant offices are valved in order that water from the city's water supply system can be piped through them in the summer for air conditioning these rooms. An auxiliary boiler has

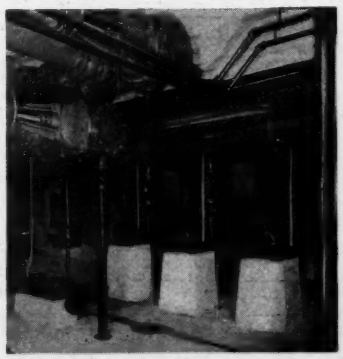

Fig. 4. Three jacket water circulating pumps; pump for circulating water through unit heaters for building heating, at the left; circulating water headers above

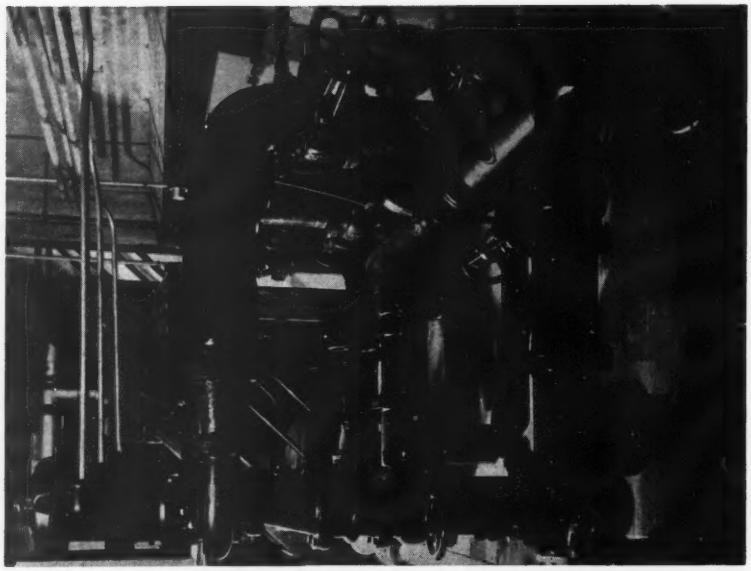

Fig. 5. Raw water pumps and piping

been installed to assist with the building heating in extreme cold weather.

Switchgear

The electrical control and switching facilities installed in the station were designed for a maximum of safety, simplicity and reliability. The main switchgear is of the metal-clad type and all breakers, rated 50,000 kv-a. interrupting capacity with a one-second current carrying capacity of 20,000 amp., are interchangeable. All breakers are electrically operated. The switchgear consists of a synchronizing panel, four generator sections, a totalizing section, and seven feeder sections. One of the feeder sections connects directly to the main station auxiliary power bank. An emergency power bank is installed and is fed through a connection to one of the outgoing feeder circuits. Lighting is supplied through a single transformer installed in the same vault with the two station power banks.

Three-phase power at 240 v. is supplied to two 600 v. convertible panelboards installed on the west basement wall between the raw and jacket water pumps. Each pump motor is connected directly to an air-breaker position on one of these boards. The various pumps, and other station auxiliaries are divided between the two boards in such a manner that the failure of either panelboard, either transformer, or either of the two power supply circuits will not deprive the plant of power for its essential auxiliaries. Motors are of the across-the-line type and are started and stopped by the air breakers. No other switching facilities are used in the motor circuits, and all contactor starting switches have been eliminated. This provides a rugged, fool-proof electrical power supply system. Control of the two-speed induced draft fans for the cooling tower is installed inside the power plant building on the operating floor in order for the operator to be able to change fan speeds without being required to go outside of the building.

A 120 v. storage battery was provided for operating the oil circuit breakers, and as an emergency lighting source which would function in the event of interruption of the normal alternating current station lighting supply.

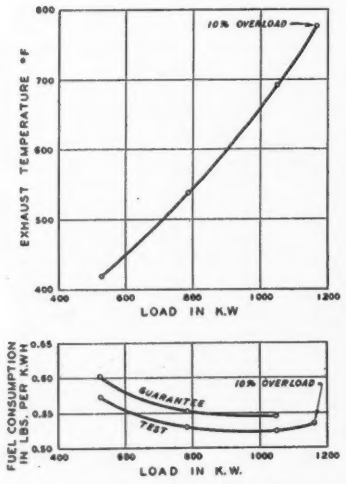

Fig. 6. Test results from 1500-hp. unit

The one unit installed in the plant is a 1500-hp., four-stroke cycle, 225 r.p.m. mechanical injection engine built by the Fulton Iron Works Co. It is direct connected to a General Electric 1318 kv-a., 1054-kw., 3-phase, 60 cycle, 2400/4160 v. alternator equipped with a 20-kw. exciter driven by a silent chain. The unit is provided with oil cooled pistons, and the governor was built by the Woodward Governor Co.

Plans have been completed for moving three engine generating units from the old plant in the near future to the new plant. Foundations are all prepared for these units, and the moving program will be undertaken so as not to interfere with the adequate supply of energy required by the community. All of the engines to be moved were built by the Fulton Iron Works Co. and consist of a 600-hp., 6-cylinder unit, a 1000-hp., 5-cylinder unit, and a 1000-hp., 6-cylinder machine.

The cost of the new plant together with the engine generating unit installed and the cooling tower and switchgear was $229,000, and after the three units now installed in the old station are moved the cost will be approximately $250,000. This includes engineering and some other incidental items. All costs of the new station are being taken care of from funds accumulated by the electric department of Algona, Iowa.

Design of the entire project and the supervision of the construction was done by Burns & McDonnell Engineering Co.

LIST OF PRINCIPAL EQUIPMENT IN NEW ALGONA STATION

Engine—Fulton Iron Works Co., Type 6KS, 6 cylinders, 1500-hp., 4-stroke cycle, 23 by 28 in. cylinders, 225 r.p.m.

Generator—General Electric Co., 1318 kv-a., 3-phase, 60 cycle, 2400/4160 v., 0.8 power factor.

Exciter—General Electric Co., 20-kw., 125 v., shunt wound, 1450 r.p.m., silent chain driven.

Switchgear—Westinghouse Electric & Mfg. Co. 12-section metal-clad switchgear with four generator sections, totalizing section and seven feeder sections.

Cooling Tower—Marley Co., 10,000,000 B.t.u. capacity with spray coils in bottom of tower, induced draft type equipped with two fans.

Cooling Water Pumps—Ingersoll Rand Co.

Air Compressors—Quincy Compressor Co., one engine and one motor driven air compressors.

Crane—Shaw-Box single motor crane of 15-ton capacity.

Mufflers—Burgess Battery Co.

Air Filters—American Air Filter Co., cycoil type.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Certainly BIGGER

— and we hope, better; at least we're going to try to make it better. Beginning with the December issue and each month thereafter the Practical Engineer and Electrician will be a 24-page section instead of the 16 pages used heretofore. The character of the section will not be changed; the same departments will appear but with the additional space we will be able to give attention to more subjects. We hope to give more space to "Letters and Comments" and to the publication of charts and engineering data in graphic form. The Prize Problem department will be retained and we hope to continue the "Shop Talk" page, but in this we need your help. We need more pictures for this page and hope that you will send them in. You all have gadgets and arrangements around your plant that are of interest to others and it is simple to take a snapshot of them for us. We haven't told Pulverizer Pete about this plan to use more space but now that he knows it, we probably will have to publish even more of his headaches than in the past. Oh yes, the section will continue to be printed on yellow paper—that, the psychologists tell us has a subtle influence in making you fellows want to read it. This, probably, is hokum but it's nice to have an excuse. In line with modern ideas we've been thinking of irradiating the section with Vitamin B_1 radiation to put even more pep into it but that might be carrying a good thing too far. It's an intriguing idea, however, and we will keep it in mind. **A. W. K.**

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

I STILL SAY THEY AIN'T

In the April issue of this year we deliberately stuck our necks out by publishing an anonymous article entitled "Engineers and What They Ain't." We should have known better, but after years of reading through monotonous technical manuscripts, editors sometimes develop a devil-may-care attitude and throw discretion to the winds by publishing something with dynamite in it. In this particular instance, the author of the article who signed himself "By One Who Isn't Either" struck a responsive cord in our hearts. We, too, began as "engineers," but for some reason or other, very probably because we were not good enough engineers, though we like to believe that it was because we did not like slip-stick pushing as a steady diet, we gravitated to or were lured into editorial work by the traditional power of the pen. Not that we have any regrets, but it is nice to have an alibi and this article furnished us with a tailor made one. ¶ Well, as those of you who read this section regularly, know, we started something. During the hot summer months these pages were made even warmer by the heat of the controversy. The unknown author was roundly denounced for his slanderous remarks and we, as editors were censured for publishing them. With the cooler Fall weather, the arguments have died down somewhat and now we present what, in a debate would be termed rebuttal. As in all controversies, however, the author has not changed his opinions, if anything the discussion has only strengthened them. So while nothing particularly has been accomplished the chances are that all of us are able to think more realistically about this question of engineering as a profession, at least, the discussion lent some color to these pages.

I READ THEM ALL, Mr. Editor, from Kohlar's prattle to Parker's squeak. I thought a good deal about those pros and cons regarding Engineers and What They Ain't and I still maintain they ain't.

After seeing Kohlar's letter I decided to blast it wide open when Gethoefer beat me to it very effectively by pointing out what a sorry state of affairs must exist when it is necessary to refer back to the days of Martha to justify a futile existence. There are, however, a few points in his (Kohlar's) letter that I'd like to touch upon. If his esteemed hero, Dr. Kildare, were to look at the smudges above the 2 on the C scale of Kohlar's omnipotent slide rule his diagnosis of Kohlar would be: "Severe deficiency Vitamin English Vocabulary". If Kohlar will refer to Roget he'll find that "conglomeration" not only connotes but actually denotes a bit more than a "sticky mass". "Accumulation" is among the common synonyms.

To continue to pick on Kohlar, I fail to see what is gained by his references to his favorite escapist reading. What he states is true, but I did not write about Doctors and What They Ain't or Lawyers and What They Ain't. In general his letter seems based on the attitude that I have attempted to make a case against his "inalienable right" to the joy of pushing a slide rule in a picayunish job until his dying day. I'm sorry if I created that impression; it was my purpose to point out to engineering students and to the fathers of engineering students what the youngster is likely to find in the profession today.

Regarding Parker

Parker's letter is a rather interesting story of a lifetime of which no small portion has been devoted to overcoming such obstacles as war, depression, and illness. As I was born in 1909, Parker is a few years older than I am and I respect his seniority and I respect his accomplishments. But I do not agree that his arguments refute anything I said and I do not agree that he is an engineer. If I read the stars correctly his letter will result in the Nth revival of the argument as to who has the better right to the title "engineer", the fellow who pulls the throttle on the Twentieth Century or the fellow who pushed the pencil that designed it. And if the locomotive driver is an "engineer" why is the trolley car driver only a "motorman".

Parker tells of his varied experiences in running boilers and machinery and in repairing everything from the lawn mower to a nurse's heart. To my mind that makes him a good operator and a versatile repairman.

If, however, he were to institute a definite maintenance program and check up on his lawn mower systematically and give his nurses a going over periodically, make adjustments and replacements *before* something breaks; and keep records to determine costs and indicate improvements; then I would call him a maintenance engineer; then he would be "planning and contriving".

Gethoefer

Gethoefer's letter indicates that in at least one instance the article served its primary purpose; it caused a cadet to give a thought to what the future holds. The lad Gethoefer writes about apparently has a mature mind and while in a sense he admits of wishing for something in engineering work that isn't there, he accepts its absence because he still finds sufficient to interest him. He speaks aptly of furlining his pigeon-hole—that's a philosophical way of looking at it and perhaps many people would be happier if they devoted more time to smoothing the rough spots of their holes in the ground instead of trying to climb out.

Williams

Williams paints a pretty pastoral scene of a Polish farmer tearing his hair and cussing a lot of young engineers because they can't fix his tractor, caponize his roosters, and milk his cows. And why should they be able to repair tractors? If the farmer goes to a doctor to get a cut leg patched up, does he raise hell because the same doctor can't fill a cavity in his teeth? In some lines of engineering, such as service and erection work, it is probably advantageous for an engineer to be handy with tools as well as with a slide rule. But why should a man who has spent four or more years in an engineering school learning how to apply available engineering data and exercise judgment also be a mechanic? There are trade schools and apprenticeships for mechanics so why worry about it if an engineer who is good at vector analysis can't replace the brushes in a motor.

I do feel, however, that Williams skirted a subject on which a great deal might be said—the choice between a trade or a profession. There is no question but that our (until the present) rising standard of living has resulted in an ever increasing number of young

men going through college. Considering only those who studied engineering—how many made a mistake? How many would be better off if they had been trained to work more with their hands rather than entirely with their heads?

Not so very long ago, it was almost an inviolate rule abroad that when a man became the best cobbler, or gunsmith, or watchmaker in his town, his son strove to follow in his tracks. Over here, if a man makes a success, measured of course in dollars, at a trade his son usually wants to go to college and study for a profession or at least a white collar job. Of course, depression years when even expert toolmakers have difficulty in finding anything resembling steady employment could hardly be expected to discourage this and the present dearth of skilled workers reflects the truth.

Every young fellow who likes to work with machinery and thinks this is a sign that he is cut out to be an engineer should ask himself: Am I interested in the machine as a machine or do I regard it as a symbol of the scientific principles behind it? If the former, think twice before studying engineering.

Now, Williams, do you really want to know why the Hero has to fight wenches and rum? Well, it's on account of the Hays Office, that indefatigable movie censorship organization. If, in the middle of a terrific, colossal, stupendous epic of the silver screen, the Hero were to pick up a bottle of Demarara in one hand, tuck a wench under his other arm and get into bed, the Hays gang would cut out the scene and wreck the continuity. And if they didn't lots of mammys wouldn't like it because it might give their daughters ideas about hunting a sugar dad in Trinidad.

Bracken

Bracken points out that the article did not touch upon all angles of the subject. I realized that from the start, but to cover all phases of such a subject would it not be apt to result in a twenty volume work entitled "Life"? I particularly enjoyed his Biblical references and the verse at the end holds a pleasant sentiment without being saccharine.

Judging from the comments printed I guess I did some "bull-in-the-china-shopping" on some pretty thin ice in the original article, fortunately no one seems to have been offended too gravely. Frankly, I was a little surprised that my remarks about design committees, standardization, and the passing of omnipotent engineering executives did not provoke more comment.

FOR THE PLANT ELECTRICIAN

Electricity's Hardened Arteries

WE HEAR a great deal these days about "bottlenecks." In almost every reference to National Defense Effort the term bottleneck is liable to come up. It is claimed that there are bottlenecks in materials, in labor, in tools and dies that keep us from attaining peak output in certain fields.

So far there does not seem to have been any major bottlenecks in the power industry as far as the nation as a whole is concerned, but all of us, at various times have come across certain instances where local bottlenecks have developed. In the electrical industry the problem has been one, not of production but of use. Many customers have wanted to take advantage of new techniques and devices in recent years, but have been stopped by one thing—inadequate wiring of homes, business places and industrial plants. Installations whose copper capacities are too small to take care of present day's demand, as expressed by Paul Heidman of the Detroit Edison Co., are the "hardened arteries" of the electrical system.

Standards of Footcandles of Illumination for Commercial Interiors

	1921	1930	1939
Private and general offices	5—10	8—10	25
Drafting Room	10—20	15—25	50
Corridors	2—3	4—5	5—8
Bookkeeping and Typing	5—6	10—15	30
Desk Work	5—6	8—10	25
File Room and Vault	3—4	8—10	20

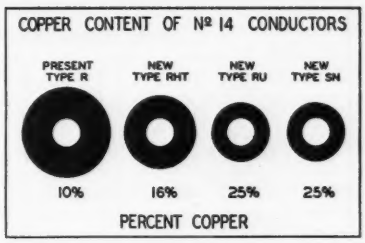


Fig. 1. Diagram showing the copper content of No. 14 conductors

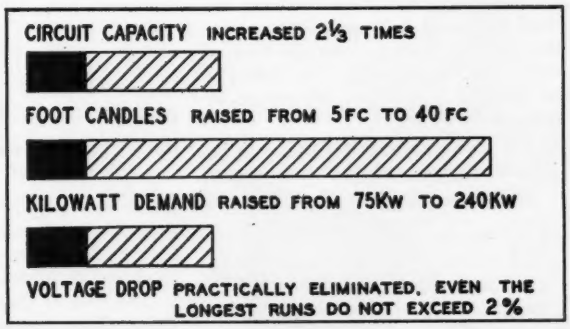

CIRCUIT CAPACITY INCREASED 2⅓ TIMES
FOOT CANDLES RAISED FROM 5FC TO 40 FC
KILOWATT DEMAND RAISED FROM 75KW TO 240KW
VOLTAGE DROP PRACTICALLY ELIMINATED. EVEN THE LONGEST RUNS DO NOT EXCEED 2%

Fig. 2. Data showing the results of one rewiring job in which the load was increased from 75 to 240-kw

Writing in the Detroit Edison Co.'s "Synchroscope" he analyzes the wiring situation from this standpoint. Twenty years ago, he points out, the building known as General Offices of the Detroit Edison Co. embodied the latest in building practices—it was a really up to date structure. Today, it is still sound and serviceable, yet some 5000 ft. of branch circuit wiring (considered more than adequate in 1921) has had to be replaced. Present electric requirements were pushing it to the limit of capacity.

An authority in the real estate field recently stated: "It is fair to assume that 75 per cent of the office buildings of the country erected prior to 1930 are at the present time lacking in wire capacity to meet the increasing demand of the electrical energy load."

The accompanying table shows how standards of office lighting have doubled and in some cases more than tripled in twenty years. Many tenants also demand air conditioning, or an outlet for their own room cooler. Restaurants, bars, and fountains have electric cooking. And offices use many more electrically operated business machines. Some have radios, electric pencil sharpeners, and even small refrigerators!

Modernization of decorations and appointments cannot substitute for adequate lighting and sufficient wiring capacity. Overloading the circuits will cause a heavy voltage drop, resulting in poor operation of appliances. And part of the electric current is paid for but never used.

Local ordinances based on the National Electrical Code hitherto have rigidly prescribed the methods of wiring for buildings. The Code, a voluntary set of regulations set up by the industry, embodies principles which have been adopted into law by various municipal and state legislative groups.

In a commercial building, for example, the branch circuits (that is, the final run from panel board to outlet or lamp) are usually made through pipes

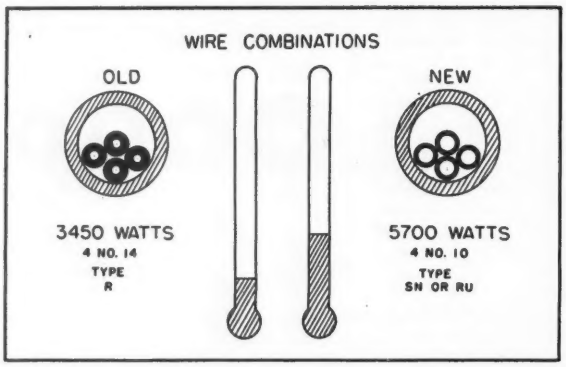


Fig. 3. Diagram showing the difference in capacity between old and new wire combinations

or conduits embedded in the walls, often in concrete. The Code prescribes the thickness of insulation on the wires, and the amount of "fill," or space in the pipe occupied by the wiring.

Any increase in wiring capacity usually means an increase in conduit size, as the original wiring used all of the space permitted. Larger conduit involves ripping out the old from solid walls, rebuilding and redecorating. Meanwhile the premises remain vacant, or tenants must be inconvenienced.

Here is a bottleneck that really cramped—it hurt the tenant, who could not get all the current he wanted; the building management, which either suffered tenant dissatisfaction or rewired at considerable expense; and the utility, which could sell more energy if it could be delivered.

However, the bottleneck has been widened appreciably by recent Code revisions. These recognized the progress made during the past several years in two respects: "thin wall" insulation, and increased conduit fill. Both now are permissible for commercial rewiring.

Wire manufacturers have developed greatly improved insulating materials for wires. In thinner layers, they perform as well as former thicker insulation. Replacing existing wire with thin-wall conductors allows more copper in a conduit without increasing the total *material.* This replacement is done simply by pulling one set of wires out and another set in.

The Code formerly limited conduit fill to 40 per cent of the interior cross-section of the conduit. This prevents binding of the wires and undue strain which might damage insulation when wires are pulled in. Experience in many locations has indicated that the safety of an installation (primary aim of the National Electrical Code) is not jeopardized when a conduit fill of 50 per cent is employed. This fill allows a quarter more wiring in the same space.

Combining thin-wall conductors and increased conduit fill vastly enlarges the usefulness and electrical capacity of existing conduit, as shown.

A number of buildings have been rewired in accordance with these revisions with very desirable results in downtown Detroit. Utility investments totaling millions of dollars have made efficient production and distribution of current possible. Advertising and sales promotion are doing an excellent job of load-building. Only adequate wiring at low cost, following the methods outlined here, can give present buildings electrical capacity for *all* the uses of electricity that modern tenants know and demand of present-day office quarters. In some instances the use of a higher voltage can solve the problem of inadequate wiring capacity. A building wired for 110 v. distribution can in many cases be converted to use 220 or 440 v. distribution with transformers at the load centers. A conversion of this kind was made several years ago at the Furniture Mart Building in Chicago with excellent results.

VARIACS IN COMBINATION

THERE ARE upon the market a number of devices for obtaining variable a.c. voltages for small power applications. Among these is the "Variac" made by the General Radio Co. This device is an auto-transformer supplying an output voltage continuously adjustable between zero and full line voltage or above. It consists of a single layer of copper wire wound on a toroidally (doughnut) shaped iron core. Rotation of a dial causes the winding to be traversed by a moving contact which "taps" off any desired portion of the total voltage across the winding. Since at least one turn of the winding is covered by the contact at all times a continuous adjustment of voltage is obtained.

The applications of this device to industrial control and the experimental work in the laboratory or test department are literally numberless. Many uses will suggest themselves, but recently two out-of-the-ordinary connections for Variacs were described in the General Radio Experimenter which deserve special attention here.

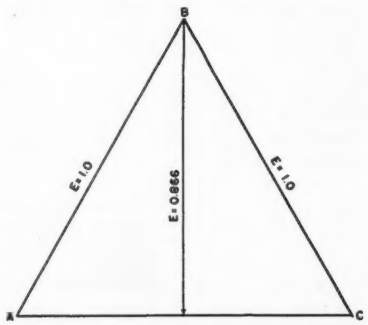


Fig. 2. Vector diagram showing the variation of voltage with phase shift

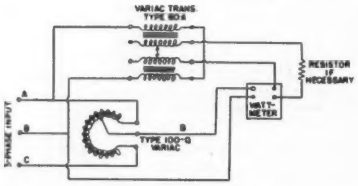


Fig. 1. Arrangement of a Variac and a Variac Transformer for varying the potential phase in testing wattmeters

The first of these, used by Louis A. Paine, Chief Engineer of Therm Electric Meters Co., Inc., uses the Variac as a potential phase shifter for testing wattmeters. The Variac is connected across two wires of a 3-phase line. The potential coil of the wattmeter is then fed from the Variac brush and the third line wire. The current coil of the wattmeter is supplied through a Variac Transformer.[1] Using this connection an effective phase variation of 0 to 60 deg. is obtainable, corresponding to a power factor variation from unity to 0.5.

The use of a single Variac to supply the potential coils has the disadvantage that a voltage variation accompanies the desired phase variation. As shown in Fig. 2, the voltage varies from unity at zero phase shift to 0.866 at 30 deg. phase shift, and back to unity at 60 deg. shift. This voltage variation can be avoided by using a second Variac as shown in Fig. 3.

The second application is furnished by Pierce Plastics of Bay City, Michigan. Here the Variacs are used for

[1]The Variac Transformer is a special type of Variac built on rectangular cores and used where only small voltage variations are desired.

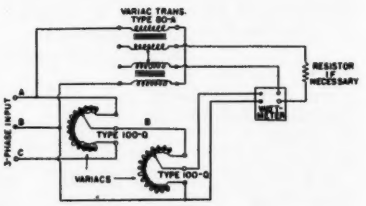


Fig. 3. By using two Variacs the voltage can be held constant as its phase is varied

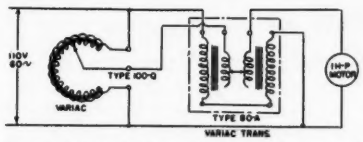


Fig. 4. Method of combining a Variac and a Variac Transformer to obtain a fine control of motor speed

speed control on a repulsion-type motor. The circuit is shown in Fig. 4. The general operating point is set by the Variac and the 10-v. winding on the Variac Transformer permits a fine control of voltage around that point.

Are You Using the Right Oils?

By Frank V. Faulhaber

GETTING the right quality of lubricating oils for the plant involves not merely the question of price, although superior oils naturally cost more. The management may be expending considerable for efficient oils, yet those in use may not be the correct lubricants. The management often presumes that, inasmuch as a better price is being paid, satisfactory oils are being procured. Unfortunately this delusion prevails in too many plants. The purchasing department, if directly buying the lubricants, contends it is doing its business. Yet, from the production lines we hear that all is not what it might be; somehow the oils in use just do not measure up.

The engineering head of one large organization once said he had a decided aversion to any lubricant having too objectionable an odor. This very detriment, in his estimation, was to its discredit and deserved due condemnation. The very fact that the oil oversmelled indicated a lack of proper refining and an unclean oil. On that basis alone it represented not the best of oils. It is not sufficient to hide such objectionable odors by perfuming. A lubricant should be chemically superior and not represent too fatty oil mixtures.

Oils that are too gummy are another kind of liability because these retain dirt, small chips, abrasives, and the like, tending to impair the bearings and slides, causing excessive wear and preventing perfect operation. This drawback is particularly well to bear in mind in connection with machinery where there is much dust and metal bits from operations.

Two vital requirements must be borne in mind when selecting oils for the lubrication of bearings. It is desirable that the power be transmitted with the least expenditure of energy and there must be maintained a complete and unbroken separating film between the moving parts of the bearing. Where there is a circulating system, the oil carries considerable heat away from the bearing.

The function of a lubricant, or its ability to perform efficiently in a bearing, is controlled by two properties: the viscosity or fluidity of the lubricant, and the adhesion of the lubricant to the metal surfaces. For light bearings operating at high speed, lubrication preferably should be with low gravity oils, whereas heavy gravity oils prove more efficient for gears or bearings of heavy equipment.

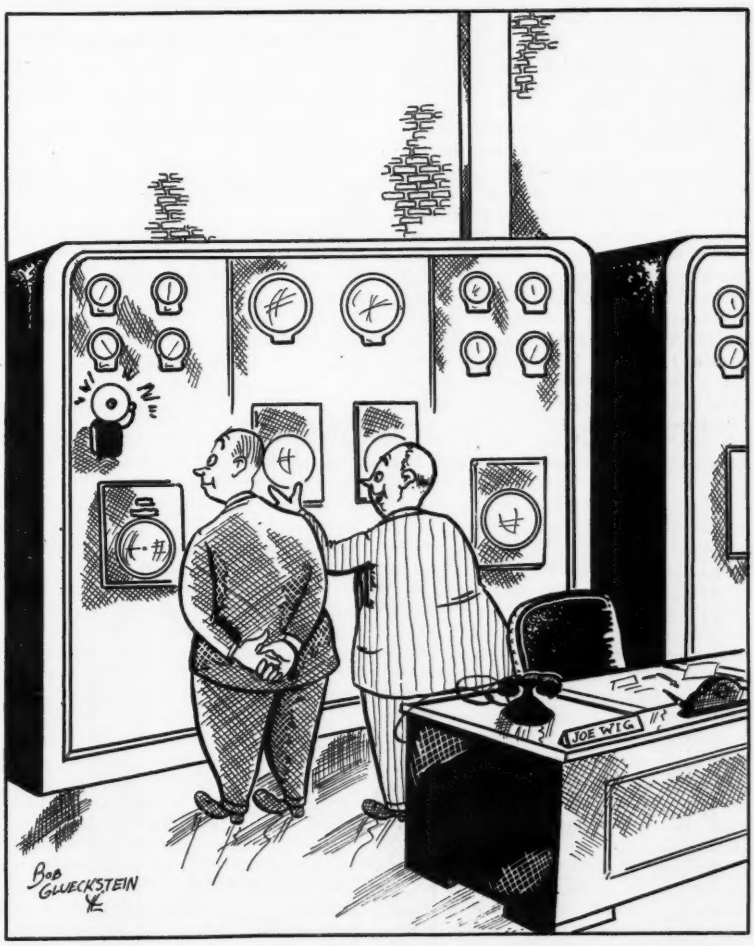
For topmost efficiency a lubricating oil should have the proper body or consistency to withstand shocks and sustain the weight or load carried by the bearings. It should furnish film strength or form a cushion between metallic surfaces of machinery in motion. Requisite also is that it withstand chemical changes due to chemical elements absorbed, and by vaporization help to dispel frictional heat.

Various tests for determining the gravity characteristics of lubricating oils can be tried, but here is a simple one that can be tried, efficaciously, by means of a piece of glass, of approximately 24 by 12 in. in dimension. The glass, preferably, should be shielded to keep it free of dust when conducting the test.

On this glass a number of drops of oil under examination should be deposited, in line. An oil having a good body and sufficient fluidity can thus be readily discovered. Oils light in substances run quickly and dry too soon; those of heavier body, being gummy or viscous, naturally will not flow as these should. The more viscous oil will not leak out so rapidly at the bearing ends, and thus will develop a greater oil pressure. When the pressure is equal to the load on the bearing, efficient film lubrication should result. Liquids of comparatively poor lubricating qualities, under favorable conditions, can give apparent satisfaction for a while by reason of the pressure-building action of the journal.

The plant management dubious of the oils in use might well experiment with more lubricants from different concerns, until the proper oils are found. Towards this end it is desirable to consult with the representatives of oil suppliers, who can thoroughly demonstrate and explain their wares. In this connection a worthy procedure is to maintain special records, preferably in a book, wherein can be retained all pertinent data and records relative to the plant's lubricants. Such information as where the oils were purchased, quantities, prices,

(Continued on page 92)



"That is a special alarm Joe's rigged up to warn him when somebody's in his locker after his tobacco"

Questions And Answers

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Why Do These Furnace Walls Fail?

Q. We are having trouble with brickwork in our Dutch oven furnaces on our vertical water tube boilers and I would greatly appreciate suggestions from readers of POWER PLANT ENGINEERING on how to remedy our troubles.

We have four 350-hp. vertical Wickes water tube boilers, set in Dutch oven type furnaces. We burn good grade of nut coal. Boilers run at around 150 per cent rating.

The trouble referred to in first paragraph has to do with sections of fire brick walls falling out. The center wall is the worst offender. This wall is 27 in. thick made of fire brick laid in air setting high temperature cement. Wall laid solid and well tied in.

This wall stood up for a year with no signs of failing and then facing sheared off in sections 4½ in. thick, or at joints on the few stretcher courses (one in four). There was no bulging of wall as is common when failure is due to expansion or to internal pressure. We have checked load carrying capacity of brick and cannot find any weakness here.

We do use high temperature refractory blocks on faces of center wall, up 18 in. and then fire brick on up 7 ft. to arch. The 9 in. thick center extends down between refractory blocks some 3 ft. to concrete beam. We have discussed our problem with several expert refractory men and have also had stoker engineers in on it. There have been plenty of suggestions, but actually so many different ideas have been expressed that we are in a fog.

The following explanations have been offered as to cause of wall failing:

1. Wall too rigid, no provision for expansion and contraction. Note: I neglected to explain that we normally have one of four boilers off the line for repairs. This means that center wall of battery is hot on one side and cool on other except when two boilers in battery are on at same time.

2. Fire brick soften and allow uneven settling.

3. Hi-tempite, air set cement used in joints sets too quick. Should use cement which requires heat to set—to prevent expansion strains in hot wall.

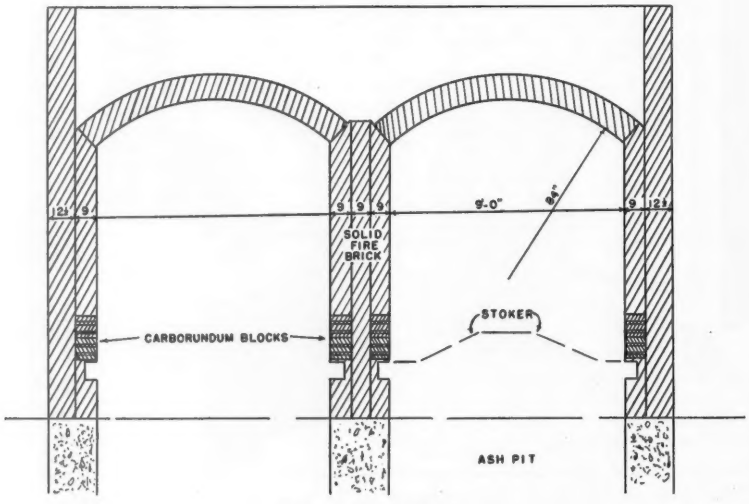
4. Should provide expansion joints in face of wall.

5. Improper distribution of air under fuel bed causing localized hot spots on wall.

The readers of POWER PLANT ENGINEERING, will, I am sure, appreciate why I do not know whom to believe, or what course I should follow.

Surely there is some good common sense solution to my problem.

A. P. NUTTER,
Works Engineer,
The Upson Company
Lockport, N. Y.



Cross section of furnace

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Will An Evaporative Condenser Work Here?

Q. Located some 40 ft. below the street level, and under a large hotel, our power plant is so compact that space is not available to provide for many functions that we would like to carry on; one being the cleaning of our condenser which is often necessary, also renewal of the inner shell (it being a two-shell condenser) due to very bad water.

We have been prevailed upon to install an evaporative condenser, and have given it quite a little thought.

I will appreciate it very much if those of you acquainted with this type of equipment will give your views and opinions whether or not it is advisable to make this change under the following conditions.

We are using CO_2 as a refrigerant and also for ice making, air conditioning, and cooling drinking water.

During the warmest weather we have a 70 ton load. The room temperature where the condenser would be required to set reaches 130 deg. F. max., and there is no possibility of ventilating with outdoor air any more than it is at present.

Should we decide to make such a change we could utilize our present water supply (which has a temperature of 68 deg. F. for cooling air for our laundry.

What size evaporative condenser should be used to suit the above conditions?

Columbus, O. G. BROWNING.

A. 104

Determining Power Costs

A. In the March issue, F. C. D. asked a question regarding the determination of power costs in the operation of a 1500-kw. turbine. Many aspects of this problem have already been answered by Messrs. Julsrud, Fox and Gabriel and Mr. De Weese who asked the question presented an interesting comment on these answers himself in the August issue, but the discussions bring out a question I have had in mind for some time. Can the manufacturers' guarantee, or any test you may put a turbine through, be an accurate gage for determining power costs over a period of time?

As a rule, manufacturers of turbines allow themselves a safety margin over their guarantee and you will find that the turbine will do a little better than the guarantee when first installed. Then as time passes on and hours of service pile up, the efficiency of the turbine will gradually decrease because of various reasons, such as wearing of valves, nozzles and blading and slight leaks which may develop in the exhaust line to the condenser. Then the condenser, no doubt, has been designed large enough to take care of any reasonable overload that the turbine might be subjected to, which will hide any increase in the water rate until it becomes great enough to overload the

condenser and cause a noticeable drop in the vacuum. The load that the turbine carries must also be considered as a turbine most efficient at full load and any wide variation of the load will cause a change in the water rate.

There are probably many other things which rob a turbine of its efficiency and cause an increase in the water rate, but cannot be detected while the turbine is in operation, and does not show up until another test is made on the turbine.

While the error resulting from these losses might be small on a daily report, in the course of a year's time it would amount to quite a bit. I can see how these losses can be detected when the entire output of a steam generating plant is converted into electrical energy, but when a great deal of the steam generated is used for heating purposes and process work, I can't for the life of me see how any one man or group of men can accurately determine the cost per kilowatt without error, unless each turbine is equipped with a steam flow meter to meter the amount of steam delivered to the turbine, a meter to measure the amount of condensate coming back from the condenser and a watt-hour meter to measure the output of the generator.

With these meters plus a vacuum gage and a barometer, a daily check can be maintained and the costs per kilowatt can easily be determined and any increase in water rate will show up immediately, and not one or two years later when a test is made. The cost of these meters is a very small item compared with the cost of a steam turbine, and I cannot understand why they are not considered as necessary as the vacuum gages, barometer, oil gages, thermometers, etc., which turbines are equipped with when installed. Well maybe that is because I am too dumb to understand, but I still think if any superior demands an accurate account of the costs they should not hesitate in supplying the engineer with the necessary instruments to do it with.

D. Osterhoudt.

Poughkeepsie, N. Y.

A. 112

Savings Due to Capacitors

A. Concerning reply to Question 112 by Walter Schmidt, Kankakee, Ill., about improvement of power factor.

The question as answered covers most of the factors involved and as stated, the ultimate action cannot be predicted since no rates are given.

As a general rule, prevailing rates may be such as to preclude raising the power factor higher than 90 per cent. This is made clearer by the tabulation which follows:

Case	KW.	P.F.	KV-A.	RKV-A.	Capacitor kv-a. for correction from Case 1
1	750	0.77	972	620	
2	750	0.90	832	364	256
3	750	0.95	790	246	374
4	750	1.00	0	0	620

To summarize:

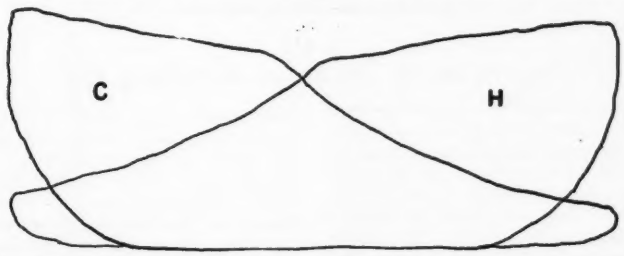
To correct to 95 per cent will require 46 per cent more capacity than it will be to correct to 90 per cent; and 142 per cent more if corrected to 100 per cent, or to put it another way, it would require virtually 100 per cent more capacity to obtain 100 per cent power factor than it would to obtain 90 per cent. The answer is, of course, the balance of the interest and other charges of the added investment against the actual reduction in the bill due to the increase in the value of the power factor.

C. O. von Dannenberg.

Brooklyn, N. Y.

140

Old Timers! What About This Indicator Card?



Q. The accompanying indicator card was taken off our double eccentric 18x30 Hamilton Corliss engine, 120 lb. press. 15 lb. back press., 150 r.p.m. 240-kw. load driving a 300 kv-a. generator synchronized with the power company's system.

The use of the indicator and the understanding of indicator diagrams seems to be dying out with the new times, but there must be many old timers left who may be able to help us in analyzing this diagram. If they will check over this card and let us know what we can do to improve it we will be grateful. Can we improve the value setting, particularly at the release end? Is there any sign of blow-by on the card, excluding possible leakage?

The card was made with a 60 lb. spring and the high back pressure will have to stay at 15 lb. as this is used in process work.

Richmond, Va. **A. A. Thieme**
Master Mechanic, Larus & Brother Co, Inc.

A. 119

Aftercooler Corrosion

A. A few remarks in regard to Question 119 as to the probable cause of aftercooler corrosion may be of interest.

As the possibility of electrolysis is already being considered, little need be said concerning it. If a difference of potential exists between the cooler and ground, means to correct the trouble by proper insulation can be resorted to. If the damage should prove to extend farther than the cooler, and insulation would not be practical, consider cathodic protection.

If electrolysis is not the fault, examine the air that enters the compressor. It may be contaminated by boiler flue gases, exhaust gases from adjacent internal combustion engines, or fumes from process work. These gases, condensing in the cooler shell, could be of corrosive and damaging nature.

Examination of the cooling water supply is in order. Corrosive water, escaping through a slight leak in the coils (provided that the water pressure were greater than the air pressure) could cause damage to the apparatus.

Wingdale, N. Y. Sam Williams.

A. 123

Copper Pipe for Gravity Return Line

A. Question No. 123 in the August issue recalls some of the experiences in days before high-pressure steam was developed.

In that time considerable copper was used for both steam and return lines. It was found that copper would not stand high pressure and temperature, therefore, other things were substituted. Wrought iron and steel pipe are the principal substitutes both on account of price and strength.

Mr. Jones having low pressure and gravity return could use copper pipe. He should consider the corrosion of copper, however, before he decides to replace his line. From the fact that he is already experiencing leakage on the return line he may be confident that he has either carbon dioxide or oxygen or both dissolved in the condensate. If he substitutes copper he will find that the corrosion is much greater at a point just beyond a joint between the copper and iron than at any other place, therefore, he must bear in mind that there will be places of accelerated corrosion produced if he substitutes copper for any part of the return line. It may be that he can cause this corrosion to take place in an accessible position in his return line. If he can, a spool can be inserted where the corrosion takes place and this spool can be removed for inspection or replacement readily.

In several instances where piping of

different materials has been required in one circuit good results have been obtained by the use of spools at the points of contact. The majority of the corrosion has thus been limited to a space or area where ready replacement can be made.

J. P. SIMONS.
Lakewood, Ohio

A. 117

The Value of Steam in Atomizing Oil

Editor's Note: The question regarding the relative economy of steam as air in atomizing oil asked by E. H. Goebels in the June issue resulted in considerable discussion, most of which has already appeared in these columns. This discussion of the subject by Geo. Holman goes so much further than all the others and attacks the question from such fundamental principles that we direct it to your special attention.

In the June, 1941 issue of the Practical Engineer I read the comment by Edward H. Goebels on the improved economy obtained by substituting steam for compressed air in the atomization of oil in mechanical burners. I was much interested in the results of the tests mentioned by Mr. Goebels, as the results of these tests parallel my own experience. I was further impressed when I read the reply to his comment by J. R. Darnell in the September issue, and the additional argument contradictory to Mr. Goebels' statement given by Marvin A. Sayland and James O. G. Gibbons in the October issue. I have studied these arguments carefully, and readily admit that the observations of Mr. Darnell and Mr. Sayland on the dissociation of steam are superficially correct. That is, the dissociation of steam at high temperature absorbs heat which it again yields up on recombination at a lower temperature. Theoretically and actually, there is no gain in heat by the introduction of steam into the burner or elsewhere into the furnace space.

Yet in spite of the fact that dissociation and recombination of steam in the furnace and boiler passes adds no thermal units to the combustion process, and may even subtract an appreciable quantity, steam—or water, for that matter—does improve the combustion process when used in the optimum amount. Ask a number of practical firemen who have used both steam and air for oil atomization, or firemen who have used both dry coal and coal properly wetted down for firing, and the majority of them will tell you, as I do, that steam or water used in the proper quantity accelerates the combustion process and increases the capacity of a furnace being forced. The results of the tests mentioned by Mr. Goebels and the opinions of a majority of practical firemen I have talked to about this matter, is more than mere coincidence, and certainly not to be dismissed by a row of figures or as sheer nonsense.

I do not question the data quoted on heat absorbed and dissociation temperatures. It is, I believe, quite correct. And no one with even a smattering knowledge of the chemistry of combustion would expect steam or water to add to the quantity of thermal units being evolved in the furnace space. Quite the contrary. What all discussing this matter have overlooked is the basic reason for introducing a heat-absorbing substance like water into the combustion process. This reason is the catalytic action of dissociated steam existing at high temperatures as free hydrogen atoms (H_1) and as (OH) ions. It is a well known fact that free hydrogen (H_1 atoms) is a powerful reducing agent. Gaseous hydrogen normally exists at ordinary temperatures and pressures as molecules, or H_2.

The action of any catalyst in a chemical reaction is hard to understand or explain. Yet many chemical processes in common use today would be impractical without a catalyst. The use of platinum as a catalyst in the manufacture of sulphuric acid is a common example. To one unfamiliar with chemistry it might be explained that a catalyst is a substance, definite for a given reaction between two other definite substances, which is introduced to promote the reaction, but which is itself usually unaffected by the reaction. A catalyst either makes the reaction possible, or makes it more violent or more complete if it is already possible, as is the case with steam in the reaction between oxygen on the one hand and carbon, hydrogen and/or sulphur on the other. While it is essential to the proper completion of the reaction the catalyst may pass through the reaction entirely unchanged. Or, the catalyst may enter the reaction itself, provided elements are present with which it can combine under the existing conditions. It is generally conceded by mining engineers that firedamp mixtures in mines often fail to be ignited by open flames because of the lack of water vapor to catalyze the process and propagate the detonating wave of the explosion.

Water or steam is so often spoken and written of as H_2O that many engineers unconsciously think of the atoms of the molecule as existing in something like that order of physical relationship. Actually, a symbol something like (H_wOH_s), in which H_w represents a hydrogen atom weakly combined and H_s a hydrogen atom more strongly combined, would come nearer to expressing the true relationship. One atom of hydrogen seems more closely related to the oxygen atom than another.

And further, some engineers assume that dissociation, when it takes place, merely separates the hydrogen from the oxygen. At the lower dissociation temperatures, however, it is quite likely that the HOH molecule breaks up at first into H_1 and OH ions. The atom of oxygen probably remains more or less loosely combined with one of the hydrogen atoms until a higher temperature is reached. Certainly this higher temperature will dissociate the molecules of pure hydrogen, H_2, and reduce it to two atoms free of attraction or affinity. In any event the free atoms of hydrogen so formed react with and by their power of reduction break up the more complex hydrocarbon molecules and enable them to unite with oxygen more readily and be reduced to final HOH and CO_2 molecules. Thus in the furnace this destruction of complex hydrocarbon molecules derived from oil or the volatile constituents of bituminous coal prior to recombination as molecules of simpler compounds is definitely enhanced by the presence of reducing free atoms of hydrogen derived from water or steam. It is also quite possible that the OH ions dissociated by the high frequency of vibration do not simply recombine with the H_1 atoms, but react with molecules of carbon monoxide being formed in the combustion process. This reaction may be expressed:

$$CO + (OH) = CO_2 + H_1$$

I need not point out that the H_1 atom could well exist at the higher temperatures in a furnace, two of these atoms joining an atom of oxygen to form a molecule of HOH as the flue gas temperature falls below the dissociation point somewhere in the boiler passes.

The greater the number of free hydrogen atoms present, the more rapid the disintegration of the complex hydrocarbon molecules is likely to be; and the greater the number of OH ions present, the more rapid the carbon monoxide being formed will be reduced to CO_2. Were it not for the fact that "steam is pretty much of a negative substitute for fuel," the combustion process could be still further promoted by adding still more steam. Because of this negative value, the quantity of steam which may be introduced into the furnace to catalyze the combustion process with free hydrogen atoms and OH ions is limited. But just as water is sprayed on coal to "temper" it for burning, so does steam in an atomizer introduced an element which, while of itself quite incombustible, certainly lends vigor to the combustion process.

I believe that I have stated my side of this argument quite clearly.

GEORGE HOLMAN

Are You Using the Right Oils?

(Continued from page 89)

attendant results, and all other relevant memoranda hinting possible later use, may well be entered in such a book. Thus, those concerned have desirable information on which can be gauged succeeding oil purchases. It is desirable also that operatives of the engineering staff and other mechanics in the plant contribute their ideas and experiences pertaining to lubricating oils, that might be of use in conjunction with the plant's records.

LETTERS AND COMMENTS

Boiler Tests Pay Dividends

THE ARTICLE by B. H. Whitehouse under the above title in the August issue, p. 102, gives incomplete data so it is difficult to check many of the results. However, he seems to have arrived at improbable figures for overall efficiency.

In Table I, based on the figure of 9.22 lb. equivalent evaporation, the efficiency should be: $(9.22 \times 970.2) \div 12{,}376$ or 72.3 per cent instead of 74.5 per cent as given. In Table II, based on the equivalent evaporation of 10.13 lb. water per pound of coal, the efficiency should be: $(10.13 \times 970.3) \div 12{,}376$ or 79.5 instead of 78.09 per cent.

A figure of 72 per cent efficiency may be within the limit of possibility using the boiler and furnace as shown in either of the diagrams on page 102, however, based on more than 20 yr. experience in power plant practice, to me it seems extremely doubtful that an efficiency figure of 79.5 per cent can be obtained using the inclined grate, natural draft stoker, even with the improved baffling as shown.

The stack gas temperature of 385 deg. F. in Table II is only 38 deg. above the temperature of the saturated steam at 114 lb. ga. pressure. I cannot conceive of such a low temperature for the flue gas, unless there was a false reading from leakage of cold air into the setting at or near the point where the temperature was taken. With forced draft which will take care of resistance through the fuel bed, a much lower draft can be maintained in the uptake, hence, less heat carried away.

In Table I the same relative condition exists. The flue gas temperature of 390 deg. F. is only 37 deg. above the saturated steam temperature for 125 lb. pressure. No figure is given for the CO_2 in Table II, but in Table I it is 8.0 per cent. Such low CO_2 means a large amount of excess air and high excess air (low CO_2) means high flue gas temperature. This was explained in POWER PLANT ENGINEERING, March 1, 1926, p. 341.

Although Mr. Whitehouse does not give any figures for Ultimate Analysis of the coal burned, we can calculate such analysis from the Proximate Analysis, (See P. P. E. April, 1941, p. 65) and then from those figures, calculate the excess air for any given percentage of CO_2.

The per cent excess air is 131 for this case. The optimum figure for natural draft stoker firing is between 50 and 60 per cent excess air.

Just how Mr. Whitehouse arrived at the figure of 88.7 per cent efficiency for coal burning alone, and for the unique figure of 115 per cent efficiency when burning coal and wood refuse is not explained.

Assuming that figures of 72 to 75 per cent possibly might be obtained when burning coal, the probability is very strong that a lower percentage of efficiency will result if wood refuse is burned on top of the coal. Wood refuse has a much lower heat value than coal and usually contains much more moisture. This means that more heat will be carried up the stack. Furthermore, when wood or other refuse is burned on top of coal, the fusion point of the ash in the coal is considerably lowered and clinker results.

There is another situation presented by the figures given in Tables I and II concerning which Mr. Whitehouse probably is unaware. When he changed the arrangement of baffles to give better heat distribution, naturally he expected to show as much coal saving as possible. Therefore, it seems strange that he didn't give himself all the assistance he could by at least having the feedwater temperature as high in Table II as in Table I. Although boiler efficiency is not affected by a change in the feedwater temperature, increasing the temperature by a source of heat, otherwise lost, causes a fuel saving.

Mr. Whitehouse does not give us a value for the temperature of the feedwater before entering the heater, but if we assume it is 80 deg. F for both Tables I and II, then the percent of fuel saved by heating the water may be calculated as follows: Saving in percent

$= 100\ (T - t) \div [(H + 32) - t]$

where,

T = temperature of water after heating,
t = temperature of water before heating,
H = total heat of saturated steam above 32 deg. F. at boiler pressure, B.t.u. per lb.

According to the above equation, heating the water in Table I, from 80 to 204 deg. gives a fuel saving of 12.15 per cent. But in Table II, since the water is only heated to 167 deg. F., the fuel saving is only 8.25 per cent. This means practically 4 per cent less potential fuel saving for Table II, in spite of the fact that the figures as given show a higher percentage for the overall efficiency.

The conclusion to be drawn from Mr. Whitehouse's article is that unless complete and entirely reliable data are available, it is unwise to attempt to make detailed calculation. We can safely say that the second arrangement of baffles should give better heat absorption than the first, but the second design cannot be given a monetary value unless we have data much more complete and accurate than given by Mr. Whitehouse.

Naperville, Ill. J. R. DARNELL

Pef to Mingle

I gather from Mr. Mingle's writing in the October issue of POWER PLANT ENGINEERING that he has never fired a boiler although on paper he may be able to carry draft calculations to the fifth decimal point.

In the third paragraph he states that if a boiler is operating normally, then without diminishing the fuel supply, if the damper is gradually closed in steps, with each step that the damper is closed, there will be an increasing amount of smoke. This is so with oil and gas firing, and perhaps with pulverized firing, but it is not true with stoker firing. My contention was for stoker firing.

Mr. Mingle or any other reader does not have to take my word. Let them go to any boiler room, or if they do not have the freedom to experiment with a power boiler let them go in the basement of their home and make this experiment with their heating boiler. Let the fuel bed remain normal. First set the damper wide open, look at the stack and make a mental note of the smoke. Then, still maintaining the fuel bed normal, set the damper at half open, later on at quarter open and each time look at the stack and make a mental note of smoke emitted from the stack. I claim that the smoke will not increase.

In my first discussion on this subject I stated that the boiler will not smoke with the damper closed tight, though the furnace is full of fuel. In this I took an extreme case, but the same thing will be true if the damper is partly closed.

I will not comment on the balance of Mr. Mingle's letter, but it is evident that he was writing it with a book in his lap. Theory and practice are not controversial, but theory has many meanings and only when we are able to demonstrate theory in practice are we able to know its real meaning and profit therefrom.

Chicago, Ill. N. T. PEF

Arguing About the Impedance of Rye Toast

PROBLEM 18
UNEVEN VOLTAGE DISTRIBUTION

How Would You Do It?

IT IS WITH extreme reluctance that we undertake this report on Our Hero's Uneven Voltage Distribution problem. Whatever we say will be held against us and after witnessing the violence which ensued at the sessions of our "Board of Judges" when they discussed the problem, and the pitiful state of disrepair in which the battle left some of the old guys, we would much rather not even touch the problem with the proverbial 10-ft. pole. As a matter of fact we have in mind disowning this "Hero" guy once and for always and send him back to the oblivion from which he came.

Our Hero's abysmal ignorance seems to be exceeded only by his childishness. We confess to having been utterly asleep when we agreed to present his so-called problem on these pages; now, much to our regret we realize that Our Hero pulled a fast one on us and that what he called *a problem* was just something no self-respecting child of seven would have given a second thought—and we are not thinking of "quiz kids."

Indeed there was so simple a solution that everybody, almost everybody, knew the answer. Those that did not give this answer probably knew it, but were ashamed to submit anything so simple. As a consequence our "Board of Judges" were up against a tough problem; they had to pick some prize winners.

UNEVEN VOLTAGE DISTRIBUTION

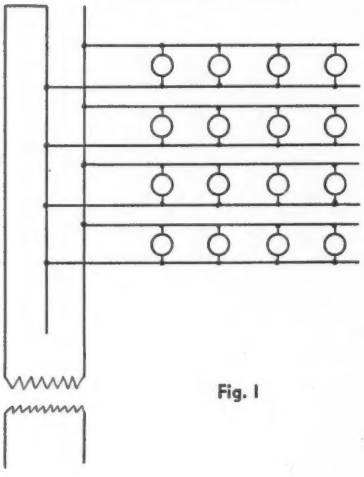


Fig. 1

The ensuing deliberations were at once brilliant and shameful. Such wrangling, such confusion, such polemics and such invective. Such an uproar has not broken the quiet of these editorial offices for years and that's saying a lot when we tell you that for 6 mo. now they have been building the Chicago subways beneath our very windows and pile drivers and air drills are certainly not anti-noise devices.

In the end the B. of J. reached an agreement but it had to "lean over backwards" so far, a number of the old guys dislocated their sacroiliacs and they have been out of circulation ever since.

Of course, it should be understood in forming any opinion of the action taken by the judges, that the prizes are awarded for the best letters, not necessarily for a correct solution to the problem. Two contestants may submit the same solutions, but one may go much further than the other in explaining his solution; naturally, this contestant receives favorable consideration over the other.

In Problem 18, it will be recalled, Our Hero wanted to adjust his system so that the circuits on all ten floors would have exactly the same voltage. To anybody knowing anything at all about circuits, there is one simple and obvious solution to this problem and that is to run an additional conductor from the transformer to the top floor, feed one of the present conductors from this new conductor at the top and the other one from the bottom.

This is the correct answer to the problem—it satisfies the conditions called for. It is not, however, the only correct answer and in actual practice it may or may not be the correct solution. The cost of installing a new (third) conductor might easily be such as to make this solution uneconomical though the chances are it would be economical. If the existing conductors were in a metal conduit there might not be space in the conduit for the third conductor and if the wiring had to be in conduit, the new conductor would have to be installed with the others. Questions of permissible voltage drop enter into the solution and so a solution would have to consider this.

Another way of getting exactly equal voltages is by means of transformers, or voltage regulators or by impedances or as Pulverizer Pete suggests, by means of resistances. In this category, C. O. von Dannenberg's solution, which because of its excellence we awarded duplicate 3rd prize, deserves attention. By the use of transformers on each floor and by using a higher feeder (primary) voltage, not only are equal voltages obtained but the voltage drop is decreased enormously. Here again, economic considerations have to be taken into account.

As already indicated there were many besides the prize winners who suggested the use of a third conductor, but not all of them analyzed the problem as well as did the prize winners.

In awarding first prize to Mr. Neill of the Western Public Service Co., the judges based their decision, First, on the recognition of the fact that the best solution depended on a number of factors. Secondly, on the discussion of several alternative schemes. Thirdly, upon the presentation of the correction in a clear logical way and finally upon Mr. Neill's consideration of the effects of voltage drop.

Mr. Thompson, second prize solution is almost the same as Mr. Neill's except that he did not go quite as far on considering voltage drop.

Mr. von Dannenberg's solution has already been mentioned. It is excellent in that it stands alone in suggesting the use of transformers for using a higher feeder voltage.

Only one other solution really stood alone and that was the one submitted

by that great versatile genius Pulverizer Pete. He was the only one to submit a coffee and toast solution, which appealed to the judges tremendously especially if they could have "dunked" their toast. It was this solution, however, which nearly brought the deliberations of the judges to a premature end because as soon as the coffee and toast was mentioned they decided it was time to eat and they adjourned court. The result was that some of the old boys went much further than coffee and toast, and even the next morning when we bailed them out of the clink they were still arguing about the characteristic impedance of rye toast as compared to just rye. It seems some of them forgot to add "toast" to the rye when they ordered.

However, enough about Pulverizer Pete's solution; let's see what the prize solutions look like.

First Prize Award

R. W. Neill
The Western Public Service Co.
Scottsbluff, Nebraska.

This is one of the most common problems encountered in an electric distribution system, and the best solution for it depends to a large extent upon the various factors involved, such as load characteristics, amount of load, length of circuits involved, cost of electric power, etc.

PLAN No. 1. If the load on each floor is constant at all times, a simple solution would be to install an auto-transformer, or booster, at each floor, which would be adjusted to compensate for the drop in voltage between floors, and so maintain a constant voltage, or rather a uniform voltage on each floor. But if the load varied on the different floors, then the voltage would vary accordingly, since the auto-transformer would step up the voltage a definite amount.

An automatic voltage regulator on each floor would maintain constant voltage at all times, but would be quite expensive.

PLAN No. 2. The simplest way to get exactly equal voltages on each floor would be to run an additional conductor from the transformer to the top floor, and feed one of the present feeder conductors at the top end, and the other feeder conductor from the lower end, thus equalizing the length of conductors supplying each floor, and the voltage drop to each floor.

Analyzing the losses in such a hook-up, the present maximum loss is 5 v. at the top floor, one-half of which is in each main feeder conductor. By feeding one of them at the top, and one at the bottom, the total voltage drop would be 5 v. in the two main feeder conductors, and 5 v. in the single conductor running to the top floor, or a total of 10 v., against an average loss of 2½ v. under the present hook-up. In other words, the wattage loss under the plan would be just four times the wattage loss under the present hook-up, and if the cost of the power was very much, the plan would not be very economical, however, it would satisfy the requirements of the problem, that is exactly equal voltage on all floors.

If the load varies, it would be necessary to change taps in the transformer as the load varied, in order to maintain 120 v. on the various floors, since the voltage drop would change with the load.

PROBLEM 19
THE RISING JACKET-WATER TEMPERATURE

This month Our Hero is puzzled over a problem put up to him by his old shipmate, C. D. McKenzie. Mac owns a flour mill in Quincy, Michigan, and has been worrying about the operation of his Diesel engine. This is a 225-hp., 3 cylinder Diesel engine providing all the power for the mill. It drives a small electric generator for lighting purposes, but most of the load is carried by direct mechanical drive through a clutch.

This engine has been running satisfactorily for a number of years and does so today, in fact, its economy is better than ever. During the past 6 mo. however, there has been a gradual rise in the outgoing jacket water temperature. During the past 3½ yr. the difference between the entering and leaving water temperatures remained relatively constant at 12 to 15 deg., but during the last 6 mo. this temperature difference has gradually increased until now it is 35 deg. Where previously the water entered at say 110 deg. and left at 125 deg., now it enters at 110 but leaves at 140 or 145 deg.

So far nobody has been able to explain this increase. Mac's first reaction to the rise was that the interior surfaces were scaled, but when he took the whole system down no scale was found. The surfaces were perfectly clean as might have been expected since only soft water is used. The centrifugal pump which pumps the water seems okay; the speed is normal and the head pressure has not changed. Each jacket outlet is fitted with a thermometer and all three indicate the same increase in temperature.

The engine runs perfectly and the load has not changed. They have checked the fuel and find that its characteristics have not changed. The firing pressure in the cylinders is the same as before, but coincident with the increase in water temperature the exhaust temperature of the engine has risen some 50 deg. Perhaps this is a clue. The engine manufacturers recommend running with an outlet water temperature of 120 deg., but when Mac took the problem to one of the professors at the University of Michigan, he said that if it was his engine he would run it at 150 deg.

So, what to do. Perhaps there is nothing wrong, yet the gradual temperature increase should be accounted for.

Write out your opinion of this case in a letter of not over 1000 words and send it to the Contest Editor by November 25. A first prize of $15 will be awarded for the best letter, a second prize of $10 and a third prize of $5. Entries should be addressed to the Contest Editor, Technical Publishing Co., 53 W. Jackson Blvd., Chicago, Ill.

Second Prize Award

Ross E. Thompson,
Albuquerque Gas & Elec. Co.,
Albuquerque, New Mexico.

The problem of supplying exactly the same voltage to all lighting circuits in a ten-story building, suggests a number of possible methods of improvement. Exactly the same voltage at each floor circuit could be obtained by providing a voltage regulator on each floor, which would be expensive and probably require more space for regulators than conveniently available. Other suggested methods are: install larger copper for the vertical feeders, run separate vertical feeders to each floor, run a third wire for neutral and change system to 115/230 v. three wire. Any one of these methods will run into excessive expense.

The one method which seems practical and comparatively easy to apply, is to disconnect one vertical feeder at the transformer, and install a third wire to connect the disconnected transformer terminal to the upper end of the disconnected vertical feeder, as indicated in Fig. 1. This would be a comparatively simple installation and would provide a practically uniform voltage at each floor. Total voltage drop to any feeder will be approximately the same as it is now at the tenth floor, but the maximum difference in voltage between any two floors will be less than one-fourth the present difference. This would seem to be the simplest solution to the problem.

Third Prize Award

Christopher M. Daly
Bridgeport, Conn.

Assuming Our Hero wants to retain his transformer with two wire secondary the thing to do is to take one feeder wire direct to the top floor, without taking any taps off it, tap on the top floor and drop down the same race way, tapping on at each floor to the first, then dead ending it.

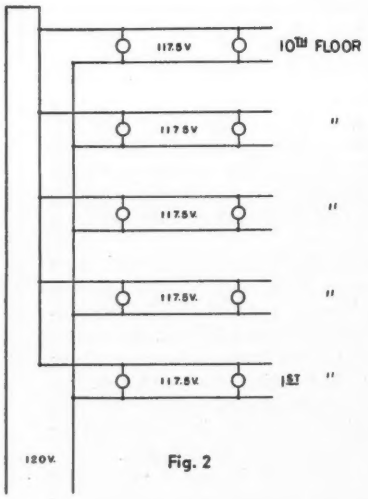


Fig. 2

Bring the other wire of the feeder circuit up the same race way, tapping on each floor in order from the first floor to the top, then dead ending it.

This will leave 3 wires in the race way from first to top floor. The most generally used lamps are 115 v. and 120 v. The 120 v. lamp should be used, which would require less amperage per lamps of 100 watts each than 115 v. lamps, decreasing the heating hazard when load is on full. Therefore, the same size wire as at present can be retained, or if load is too great present wire (feeders) could be replaced with new type building wire which can be used at higher temperatures.

It is not advisable to use a higher voltage tap, such as 130 v. tap, to overcome the drop at full load because if many lamps were switched off the life of the remaining lamps would be shortened due to a rise in voltage. Therefore, the 120 v. type should be used.

In the sketch it showed a 115 v. on the top floor and 120 v. on the first. We will assume that is the voltage with 115 v. and 120 v. lamps in place (a 5 v. difference) or 4.8 v. drop if using 120 v. tap of transformer at no load.

In this new arrangement of feeders the drop will be uniform on all floors.

The voltage on each floor will be about 117.5 v. (if same size feeder is retained) about 2 per cent drop. Then if a great many lamps are switched off the voltage will not go beyond the point the lamp was designed for.

Now it can be seen Our Hero's lighting load has gone beyond demand, when by using this remedy, the drop, is still a little low in accordance with the (National Underwriter's Code of 1941, Article 220 [Feeders] 2202 voltage drop) which only allows 1 per cent drop on lighting and combined lighting and power loads.

In order to overcome this, he can install larger size wire, (if his race way allows it) which would be the proper way and where possible to use fluorescent lighting fixtures that would give him the same foot candles with less amperage on his branch circuits.

Duplicate Third Prize Award

C. O. von Dannenberg
Brooklyn, N. Y.

The simplest solution of the problem would be to increase the voltage of the 2-wire vertical riser, feeding all the floors, to 440 v. and installing 440-v. transformers at each floor to reduce the value to the actual lamp circuit voltage of 115 or 120 v. This could be done with a minimum amount of work.

A modification of the foregoing would be to group the floors and feed them from one transformer instead of a separate transformer for each floor. Lacking knowledge of the load conditions does not permit comparing the two methods fully.

Raising the voltage of the vertical riser to 440 would reduce the drop in it in the proportion of $(115/440)^2$ or to 0.066 of its previous value to which would be added the regulation of the transformer although the total would be less than the previous drop by a substantial value. In addition, the changes would consist simply in cutting off each floor circuit and inserting the 440/115-v. transformer in the break; it could readily be mounted on the wall above the panel box. Suitable secondary taps would permit varying the voltage at each floor to suit the actual existing load conditions while the increase of any floor load could be taken care of by changing the transformer to a higher or lower capacity.

The change from 115 to 440 v. in the vertical riser would, of course, reduce the current in it in the same proportion 115/440 or 0.262 of its previous value and thus permit an increased load to be handled.

General Comment

As already indicated, this last solution by Mr. von Dannenberg is interesting because it was the only one of all the solutions submitted that attacked the problem in this manner. Of course, it was implicit in the statement of the problem that the question of voltage drop was not a factor but it is clear that any solution which takes the voltage drop into account and which at the same time meets the requirements regarding equalization of the voltage deserves comment. The solution presented by Mr. von Dannenberg is a practical one and one which has been used in certain buildings in late years to increase the load carrying capacity of the existing wiring systems. The inverse square ratio between voltage and the size copper required is a factor that should be kept in mind in the design or redesign of all distribution systems.

Honorable Mention

So much for the prize winning solutions. As already mentioned, a considerable number of letters contained the correct solution, but in many instances the presentation was too brief to put them in the prize-winning class.

Another number, however, were more explicit and they deserve honorable mention. Among this group, for

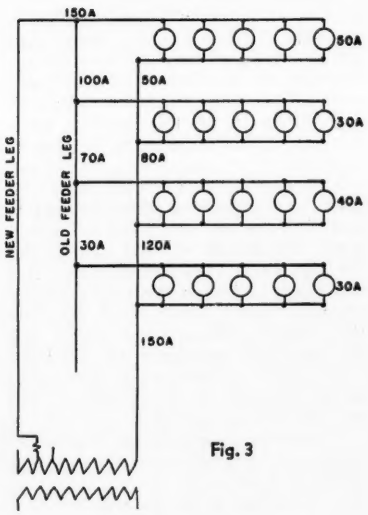


Fig. 3

example was Henry E. Zeffren's solution. While he submitted exactly the same circuit as Mr. Neill and Mr. Thompson, in addition he presented a detailed mathematical analysis of the voltage drop across various parts of the system, proving that the voltages on the various floors will be equalized by revising the circuit by the addition of the third wire. The circuit, quite obviously needs little mathematical analysis, it is quite obvious from mere inspection, but it is of interest to know that its effectiveness can be demonstrated mathematically. Mr. Zeffren's analysis is too long to permit presentation here, but his efforts merit mention.

F. R. Varing's solution is another deserving mention. After discussing the possibility of making changes in the wiring circuit and assuming that a new feeder conductor can be added, he not only presents the correct circuit, but shows by means of assumed loads on each of the floors, exactly how the current is distributed in the circuit. This diagram is shown in Fig. 3.

Others sending in correct solutions or diagrams are as follows: E. Winholt, Wm. N. Kitts, Geo. McNally, Rutledge F. King, C. J. Holslag, G. C. Pride, Jesse L. Erisman, and, last but by no means least, that great versatile genius, Pulverizer Pete.

It seems a little bit unjust that such originality as that which combines the question of voltage equalization with coffee and toast should go unrewarded, but it is not for us to question the wisdom of our Board of Judges. After all, we packed this particular court so we can't very well criticize its de-

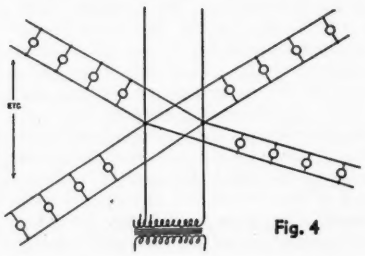


Fig. 4

HERE *Today* . . .

GONE TOMORROW

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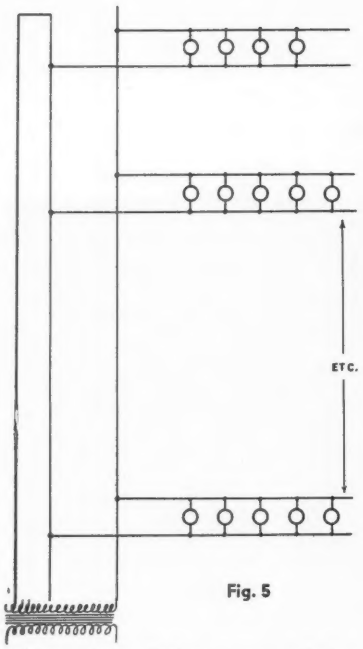


Fig. 5

cisions. Nevertheless, any solution which in one grand sweep takes in coal dust, a third conductor and toast and coffee, deserves mention and so we present Pete's letter as follows:

"Dear Contest Editor" (sometimes he calls us other names). "Dear Contest Editor," he writes, "so, you has again got your Hero stuck with a

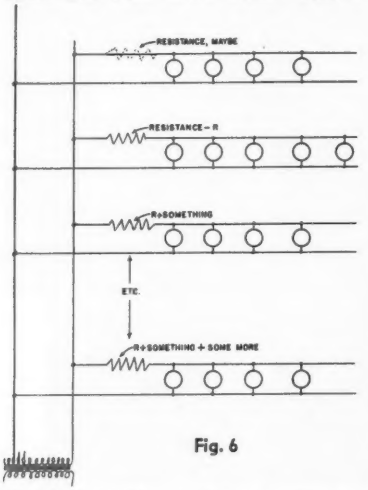


Fig. 6

electrical problem. I knows it was too good to last, you couldn't let the emfs rest, could you?

Now, there is one answer which is so obvious that it surprises me how come you don't know it and keep the prizes for yourself. Anyway it is like this. You paints all the light bulbs with water glass. While it is still nice and gooey you goes downstairs and throws some coal dust on the lamps downstairs which is the ones which is the most too bright. Yes, the coal dust cuts off some light. Then you goes to the second floor where the lamps is a not so much too bright and throws on not so much dust for to cut off not so much light. Now you climbs to the third floor where the lamps is still less too bright and throws on still less not so much dust and cuts off a still lesser amount of light. Now you takes a rest. When you is able to climb some more you does the same for six more floors. Then, if you has done your dust chucking right all the lamps below the tenth floor ain't no brighter than the ones up there.

So now I really reads the problem and I sees where what you really wants to do is get the voltage on all circuits the same. That's easy, all you gotta do is take all the circuits from the feeders at the same point like in Fig. 1.

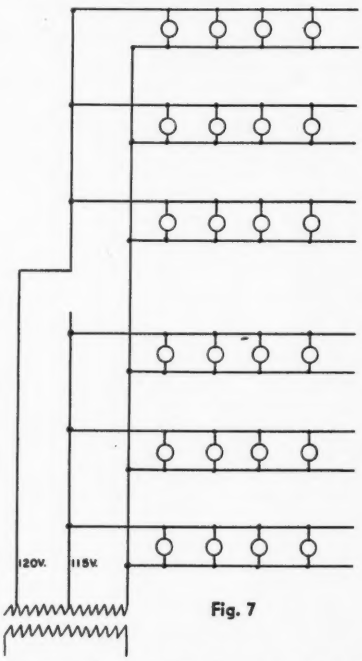


Fig. 7

But knowing you like I do, that don't get me no prize. It gives you a idea, though, don't it? If the length of feeder to all circuits was the same they would all get the same voltage wouldn't they? For to do this is easy, you hooks on a wire to one of the feeders at the top and runs it all the way down to the first floor where you connects it to nothing. Then you takes one side of all the circuits off the feeder you just hooks a wire to and hooks them onto the new wire. This then looks like I shows in Fig. 2. Now if you takes a ruler and measures this thing you sees where the length of feeders between each circuit and the transformer is the same and the voltage drop is the same whereupon I says with glee: Q.E.D.

But don't relax yet; I figures the first prize is worth one more answer. And this one don't use up none of your wire. First you adjusts the tap on the transformer for to give you at the top floor what voltage you want. Now the voltages at the underneath floors is all too high so in each floor as you goes lower down you puts a little bigger resistance in the lamp circuit to cut the voltage down to what you wants. See Fig. 3. If no tap on your transformer gives you what you want on top you can use a resistance there too. How much power you dissipates in your resistances depends on how many lamps you got, but maybe you gets enough heat for to make toast and coffee.

Impedances is probably more economical on the current but they is more expensive, harder to get adjusted, and wouldn't fit so good with the remark about toast and coffee.

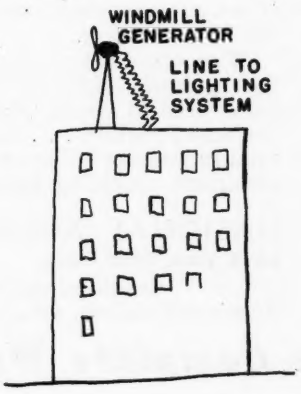
Pulverizer Pete

Among those who submitted *different* solutions to the problem, W. A. Wood's of Cleveland, O., is quite novel. Mr. Wood suggests cutting one of the existing feeder conductors at the fifth floor and then to extend an additional wire from the end feeding the upper floors to the transformer. The lower five floors should be fed by the normal 115 v. secondary winding of the transformer as at present, and the new conductor should be connected to the 120 v. tap to feed the upper five floors, the return wire being common to both circuits. Mr. Wood did not submit a diagram but from his description, the arrangement would be as in Fig. 7.

As Mr. Wood points out, "if the wiring is open in raceways, it should not be difficult to pull in the two wires. However, if it is in conduit the present two wires may be replaced by three or possibly four wires of the new code type of thin-wall insulation. Should the 3-wire scheme be used, all 3 wires must be in the same conduit."

Glen Browning thinks Our Hero's problem is the nuts so, he says, is Our Hero. In wrestling with his various headaches, each succeeding one leads me to believe more firmly that he is operating a junk yard, even if in this case it includes a 10-story building.

One contestant who signs himself an Apprentice in Engineering, treads on dangerous ground in attempting to compete with that versatile genius P. P. He suggests the use of a windmill generator mounted on the roof and feeding the system from the top down. This, to our Board of Judges was a goofy way of overcoming voltage drop. They argued that the voltage would drop 10 stories in less time than it takes to tell about it and Our Hero would only get more headaches taking care of the windmill.



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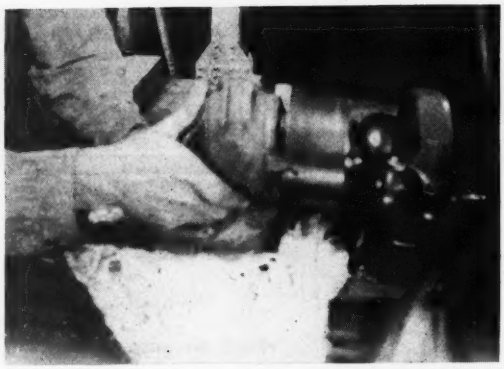
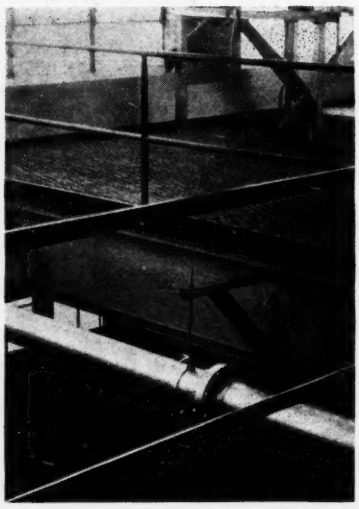
SHOP TALK

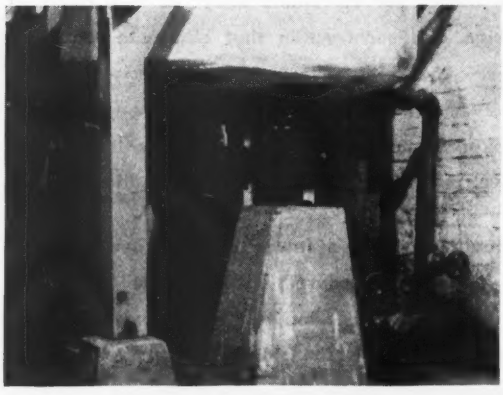
A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.



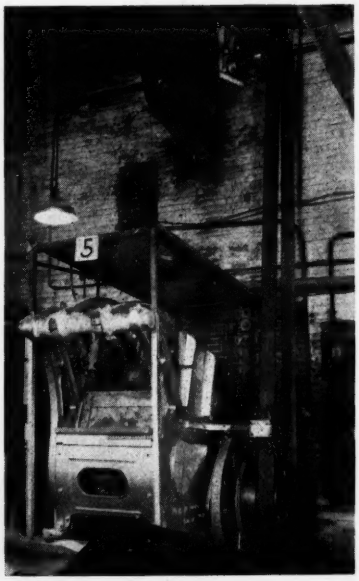
REFACING VALVE GATES. The photograph at the right shows how Leslie Bradley of Bismarck, North Dakota, refaces valve gates in a lathe. He has refaced many gates in this way. A different size face plate is used for each different size valve gate. As shown in this picture the faceplate is held in the chuck of the lathe and as it rotates the valve gate is held by hand lightly against the plate. The photograph is not very clear, but the method should be quite obvious and available to any operator having the use of a lathe.



WELDED PIPE SUPPORT. Electric welding can be used to advantage in many places around the power plant. The picture above shows a convenient method of supporting pipe from angle irons welded to the building steelwork..



STEAM SEPARATOR SUPPORTS. The view at the left shows the method of spring support used for steam separators at the plant of the Clifton Paper Co. in Clifton, N. J. Mounted on heavy steel springs on concrete piers this separator is free to vibrate without communicating this vibration to the rest of the building structure. This arrangement has been applied successfully in a number of cases in this plant.



RUBBER BELT. In the photo above is shown a difficult but highly satisfactory belt drive. It is on a drive of a "felt bumper" in the plant of a large eastern hat manufacturer. In this tub several dozen hats are alternately pounded by two large hammers. Inertia in the hammers creates an overload every time the drive is shifted. Furthermore the belt is constantly being sprayed with water and frequently spattered with sulphuric acid used in treating the felt. Despite this difficult service this Goodrich rubber belt has been in operation for over 3 yr., operating satisfactorily and with no time lost.

FREQUENCY METER. Mechanical vibrations in this 25-kw. motor-generator set are quickly and accurately measured with this reed-type Westinghouse vibrometer. No larger than a slide rule, the instrument will indicate separately all primary frequencies and harmonies within a frequency range of from 500 to 20,000 cycles per minute.

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Risks in Handling WIRE ROPE

Personal injuries and infections sustained by workmen in caring for wire rope used about power plants can be reduced by strict adherence to safety rules

BY F. L. SPANGLER

PLENTY of information is available on the selection, installation, inspection, and use of wire wire rope to insure protection to individuals and property. Very little information, however, has appeared on the other risks connected with the handling of wire rope; specifically, injuries and infections resulting from puncturing of the skin by the ends of broken wire sticking out from wire rope; bruises and other injuries caused by the violent whipping or lashing of a rope or flying out of the strands when the rope breaks or an end comes loose while the rope is in tension; and injury caused by a man's hand being pulled into a drum or sheave due to the wire wickers grabbing the man's glove.

In an effort to determine the extent of these lesser known injuries among employes of power and light plants who handle wire rope, and to learn what is being done to eliminate or reduce the number of such injuries, a questionnaire was sent to a representative list of power and light plants.

Hazards Recognized

Of 27 questionnaires filled out and returned, 14 admitted the danger that exists in handling wire rope, and some of the remaining 13 said that minor scratches have been experienced from time to time. This indicates that the hazardous nature of wire rope, especially if not properly handled, is recognized by most power companies.

One company points out that projecting ends of wire may cause hand injuries, and other injuries may result from a loose end flying when the rope is strained to the breaking point. Another points out the danger of exposure to frayed ends, while still others mention the danger of getting caught by the rope while in motion, and unusual twists which might cause the rope to spring and strike a workman or bystander. One writes: "Wire rope, like all other useful tools, is hazardous if not used in a proper manner."

A few give details of specific cases of injuries, among which are:

"A man killed in a mine by grabbing a cable while it was in motion."

"In one of our power plants, a maintenance mechanic was operating an air hoist, raising a tray of ganister from the ash room floor. He was using his right hand to guide the cable over the drum of the hoist. A broken strand of the cable caught his glove, pulling his hand in between the drum and the cable."

"A man was injured by a strand of cable piercing his hand. Infection developed because the injured person did not receive immediate treatment and apparently was unaware of the steel splinter in his hand until infection had set in."

Minor injuries sometimes occur to men while splicing wire rope, says another company. Others report smaller scratches and puncture wounds caused by broken wires sticking out from the rope and from frayed ends of the rope, but resulting in no lost time.

Many suggestions are offered on how to eliminate or reduce injuries caused by wire rope. Ten companies suggest the need for regular inspection and either frequent replacement or bad ends of rope cut off. "When wires start breaking, it is usually near the end of the rope," says one safety supervisor, "and this piece is cut off. The next step, the wire rope is taken off the drum and reversed end for end. The rope is replaced when necessary."

Seven companies report that they use preformed rope, since the wires of this rope do not stick out when they break and the ends of the rope do not fray, thereby eliminating much of the danger from this source. "Preformed strands tend to stay in place, thus reducing the hazard," writes one; another says, "Preformed rope has eliminated much of the fraying of strands"; while a third company states, "Preformed rope is not so hazardous to handle."

The wearing of leather protector gloves is suggested by five companies as desirable in reducing the injuries caused by handling wire ropes. In four replies, caution is given against overloading the lines, and two other companies warn against abuse of the rope by bending sharply or by being pulled over sharp edges. One safety engineer suggests that riggers be furnished with Safe Load Tables bases on a factor of safety of five. "Too many men," he says, "think ½-in. plow steel cable is good for 10 or 11 tons on a single hitch!"

Three companies stress the need for proper lubrication, which, as one says, "keeps moisture out and prevents rusting and the wires from breaking."

One company issues a warning against allowing rope to slide through the hands while winding on the winch drum, since this may lead to lacerations of the hand or may result in the hand being pulled into the drum. To eliminate the danger from frayed ends of a rope, one company brazes the ends.

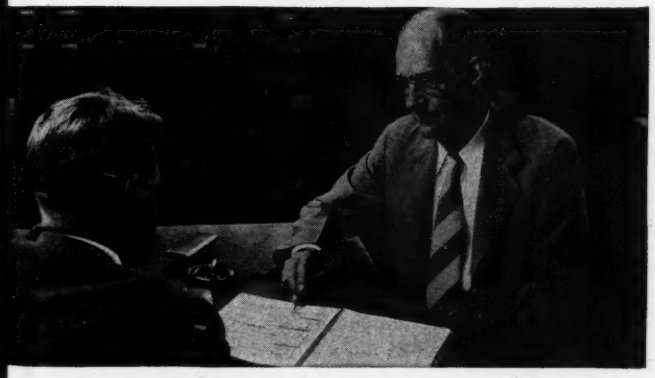
Eighteen companies report that their safety programs have been stepped up in recent months to keep abreast of increasing power output. One safety supervisor says, "Our program is a continuing one and we try to maintain interest regardless of the times." From another: "A standard safety program is carried on at all times. Special attention is given to certain groups only when an adverse trend makes it necessary." Several companies are giving particular attention to educating new employes in safety, one reporting that they had added a hundred new employes in the 6 mo. just prior to the date of the report.

GAS ATTACK

Scovill's 3-Way Service Ends Hidden Threat to Condenser Tube Life

SERVICE IN MEN. Destructive action from an unknown source was causing consistent failure of this plant's Admiralty tubes — and the failures always occurred at the same definitely localized spots. Scovill consultants examined the installation and sent samples of the metal to Scovill's laboratories for analysis.

SERVICE IN METALS. Analyses indicated chlorine in a ferric chloride solution, dripping onto Admiralty tubes, severing them from the tube sheet. After thorough plant investigation, and location of chlorine leakage, Scovill recommended a few simple installation changes which ended this costly, chronic trouble once and for all.



SERVICE IN MANUALS. Thus, into a Scovill manual went another page of practical Condenser Tube experience, available to every Scovill customer. Write today for *your* free sample Condenser Tube Booklet, addressing 17 Mill Street, Waterbury, Connecticut.

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WATER TREATMENT
For Embrittlement and Carryover

DEFINITE progress is being made in the treatment of water for use in steam boilers through research and development work conducted by a number of technical organizations. In a paper before the recent Midwest Power Conference, Professor Frederick J. Straub summarized the conclusions of this work and classified boiler water problems into those having to do with the prevention of scale, corrosion, embrittlemen and carryover. Scale and corrosion are old enemies that are yielding to proper treatment. Embrittlement and carry over are problems of a newer type and not so well understood, of these, Professor Straub made the following statements which indicate that progress is being made.

Embrittlement

For years it has been officially recognized by the A. S. M. E. Boiler Code Committee who recommended that attention be paid to the boiler water treatment so as to keep definite ratios between the sodium sulphate content and the alkalinity of the boiler water depending on the steam pressure in order to prevent this trouble. From all records which have been submitted to this Committee, it appears that the maintenance of these sulphate ratios have prevented embrittlement in many power boilers. Many instances of embrittlement have been reported in the absence of these ratios whereas no cases in stationary boilers have been reported where these ratios have been maintained.

Needless to say, there are other inhibitors of embrittlement besides sulphate. Years ago Professor Parr and the author called attention to the possibility of using tannates, nitrates, phosphates, etc. to prevent this trouble. Much work has been done by the Boiler Feedwater Studies Committee in co-operation with the A.R.E.A. at the U. S. Bureau of Mines in recent years along this line. This work has shown various organic materials as well as the nitrates to be effective in preventing embrittlement.

During the years the fabrication of boilers has been improving with the result that with the introduction of the welded rivetless boiler embrittlement has become almost impossible. Consequently, in the newer plants having welded drums the question of water treatment to prevent embrittlement is easily answered. However, the operators of the older riveted boilers still have to watch their water treatment so as to prevent embrittlement.

Carryover

Carryover is a term that has been used to cover the entrainment of boiler water in the steam leaving the boiler. The solids in the boiler water both dissolved as well as suspended are carried into the steam resulting in deposits forming in the superheaters, on turbine blades, valve seats, etc. If the carryover is excessive—such as to cause loss of superheat—the difficulty receives immediate attention. When the carryover is small, however, it quite often goes unnoticed until turbine blade deposits are found or until valves freeze. In general, it is desirable to obtain as pure a quality steam as possible. In the larger plants continuous records are kept of the conductivity of the steam and any change in the conductivity curves immediately indicates carryover. In order to have these curves indicate carryover, however, the steam sample must be free from or corrected for the gases such as CO_2 and NH_3 which are present. Temperature corrections must also be made. In the smaller plants such recording equipment may not be necessary and a small continuous sample of the condensed steam flowing through a bottle quite often gives visible indications of surges of carryover. Portable conductivity instruments may be used to check the steam under the various conditions of operation. Here again attention must be paid to the dissolved gases as well as the temperature at which the measurements are made.

In order to protect turbine blades from deposits, it is essential that the carryover be low. Quite often a proper balancing of the chemicals within a boiler will give a non-adherent carryover which will not cause blade deposits.

The Modern Steam Turbine

(Continued from page 61)

Modern turbine design would be incomplete without some reference to the 3600 r.p.m. alternators. These machines are of two pole construction and set up two forms of disturbances of 7200 cycle frequency, that is, at a frequency twice the running speed. The first effect was a result of the inequality of the moment of inertia of the rotor on the axis of the poles and the axis at right angles to that of the pole slots.

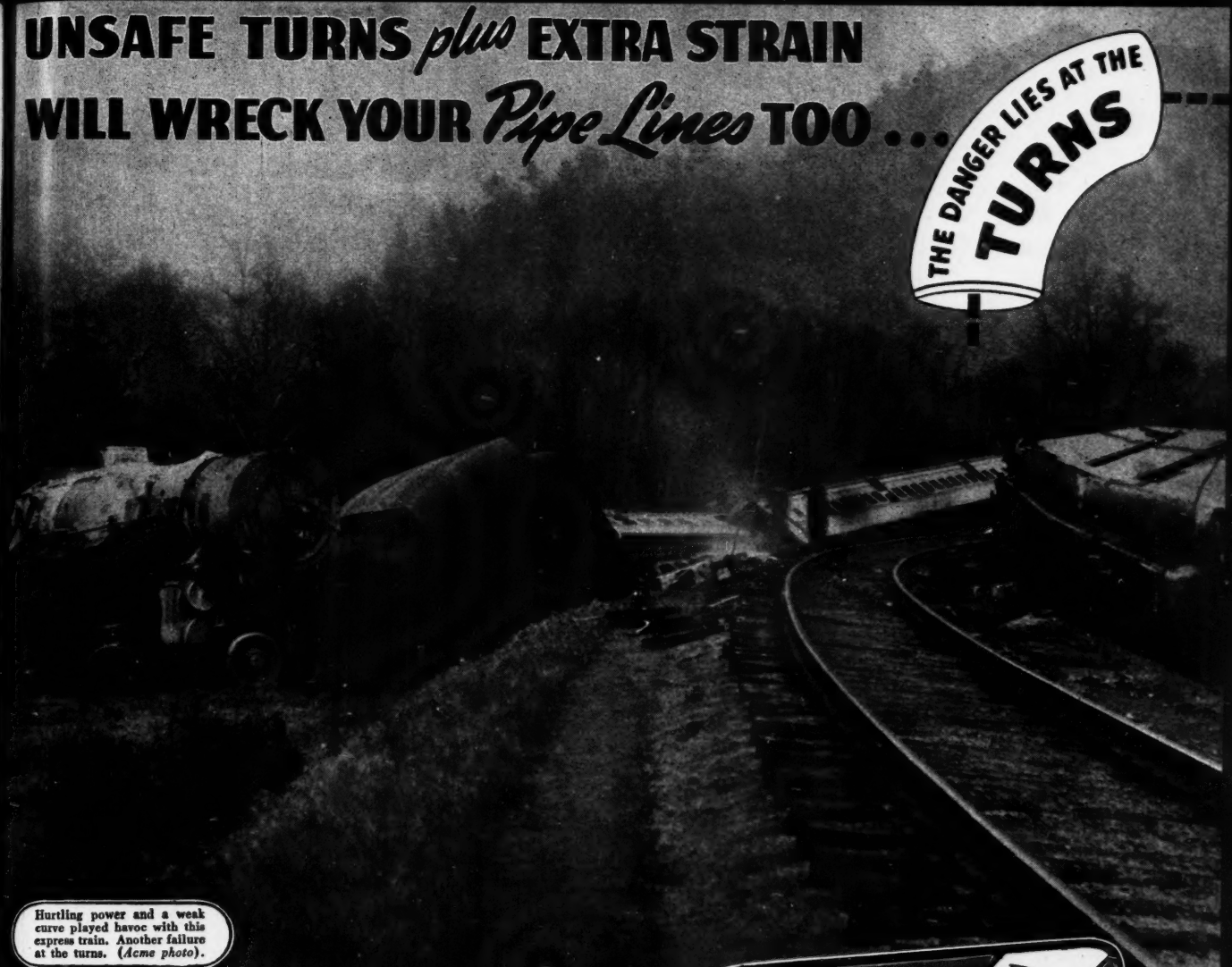
This tends to cause two flexings during each revolution of the rotor and resulted in a "whip" at the journals. This effect was eliminated by cross-slotting the rotor, thereby equalizing the moment of inertia on the two axes. By producing these slots at right angles to the surface of the rotor, as shown in Fig. 1, the desired equalizing effect was established with minimum removal of rotor material.

The second effect was due to the magnetic distortion of the stator which transmitted a 7200 cycle frequency vibration through the generator frame and out into the foundation and associated numbers. This vibration is picked up by flat plates, ducts, and in some cases the resultant noise was very annoying. The amazing phenomena of this vibration is that an amplitude of less than one thousandths of an inch at the stator causes the disturbance.

Experiments disclosed that the combination tangential and radial motion characteristic of the stator vibration, changed to pure radial motion at a certain distance beyond the outer surface of the stator core. This discovery provided for a solution to the problem and the stator was separated from the frame and connected by a stable, three point suspension which gives freedom of motion in radial directions, with necessary rigidity in tangential directions. This stator construction as shown in Fig. 3 prevents the transmission of the vibratory forces into the frame and consequently eliminates the undesirable effects.

UNSAFE TURNS *plus* EXTRA STRAIN WILL WRECK YOUR *Pipe Lines* TOO . . .

THE DANGER LIES AT THE **TURNS**



Hurtling power and a weak curve played havoc with this express train. Another failure at the turns. (*Acme photo*).

Weld your piping with TUBE-TURN fittings for stronger, safer, trouble-free, "turns"

Many railroad disasters happen AT A CURVE—because that's where strain and wear hit hardest.

Piping systems face the same hazards. Pressure, friction, stress, and erosion punish your lines worst *at the turns*—wherever there is a change in direction.

That's why it is sound engineering to insure the *utmost* safety and strength at these danger points with TUBE-TURN Welding Fittings.

Welding with Tube-Turns gives your plant the assurance and economy of piping systems with longer life, better performance, space-saving layouts and virtually no maintenance interruptions.

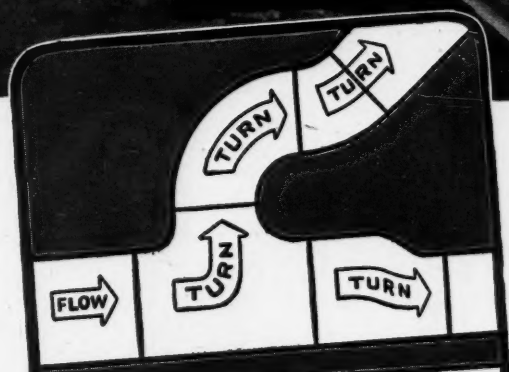
Write for helpful Tube-Turns engineering data book and catalog.

TUBE-TURNS, Inc., Louisville, Ky. *Branch offices:* New York, Philadelphia, Chicago, Pittsburgh, Cleveland, Tulsa, Los Angeles. Distributors everywhere.

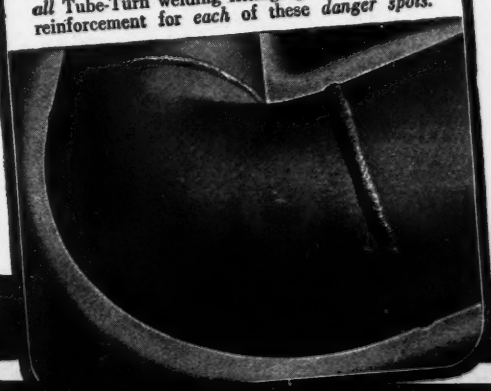
TUBE-TURN

TRADE MARK

Welding ★ The ★ FIRST WELDING FITTINGS 1ST AND STILL THE BEST *Fittings*



As indicated in the drawing above, there are vital "turns" in piping other than at elbows and returns. Tees, reducers, laterals, and nipples likewise entail abrupt changes in flow direction that result in *added* strain, friction and wear at these connections. The built-in strength of *all* Tube-Turn welding fittings gives unequalled reinforcement for *each* of these *danger spots*.

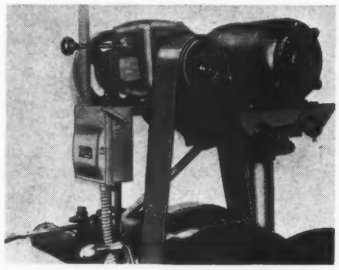


New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Transmission Gear

AN IMPROVED transmission for use in motorizing cone-driven machine tools has been recently announced by Western Mfg. Co., Detroit, Mich. The new design of the Western master transmission permits a more compact unit and with the shifting lever moved into the main body of the transmission, more



positive action and better feel is the result. This model is designed for use with 1-5-hp. motors and is adapted to all kinds of machine tools with three models of Multi Motor Mounting; 1. Lathe Bracket. 2. Shaper Bracket. 3. Milling Machine Bracket.

It is built for heavy loads with transmission case and covers of semi-steel castings that are oil-leak proof. The gears and spline shafts are of alloy steel. All revolving shafts are mounted on anti-friction bearings and moving parts run in an oil bath.

Water Analyzer

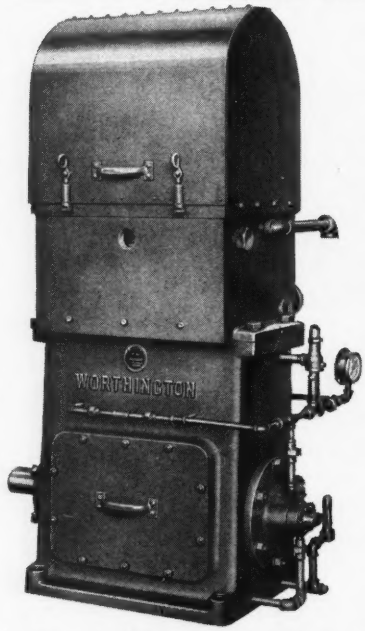
THIS OUTFIT, put out by W. A. Taylor & Co., Baltimore, Md., is designed for determining pH, color, total iron, silica, nitrates, etc., in water by the methods given in Standard Methods

of Water Analysis (A.P.H.A.). Color standards are enclosed in plastic slides, made by placing the sample, to which the necessary reagents have been added, in the middle tube, moving the slide until a color match is obtained by observing the colors in the mirror and reading the pH, silica content, etc., from the values engraved on the slide.

With the Taylor Water Analyzer the proportion of indicator solution added (0.15 cc.) is so small as compared with the volume of sample (22.5 cc.) that the effect of the pH of the indicator solution is practically eliminated and the same results will be obtained with both bromthymol blue and phenol red and a test with chlorphenol red will show that the pH of the sample is above 6.8 for a bromthymol test of 7.0.

High-Pressure Triplex Pump

THIS VERTICAL power pump is announced in 8 sizes for pressures to 9800 p.s.i. and capacities to 51 g.p.m. by Worthington Pump and Machinery Corp., Harrison, N. J. It is single-acting and suited for hydraulic presses, plastics manufacture and special process work.



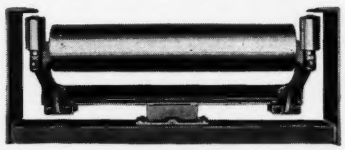
No reduction gears are used; gear-head motors are built in, although V-belt drive can be provided; plungers are out-board with dry joint between liquid cylinders and power frame to eliminate possibility of leakage between cylinders and crank case.

Self-Alining Idler

FOR automatically correcting misalinement of either carrying or return runs of non-reversing conveyor belts supported on flat-roll idlers, Link-Belt Company, Indianapolis, Ind. has developed a new swiveling, positive, self-alining idler.

This new idler has a centrally pivoted cross member which, besides being equipped with a flat idler roll for supporting the belt, has a vertically-mounted actuating roll at each end for lightly contacting the edge of the belt when its lateral misalinement exceeds a predetermined amount.

A slight pressure of belt edge against an actuating roll serves to swivel the idler unit on its pivot sufficiently to guide the belt automatically, quickly, positively, back to proper alinement.



When used on return runs, one idler should be placed close to tail or takeup shaft so that the belt will be guided centrally on the pulley, and one at every ten or fifteen idler spaces. On the carrying run, one idler should be placed just beyond the loading chute, and one at every ten or fifteen spaces thereafter.

For flat-roll belt conveyors that must operate in either direction, self-alining idlers of special design are available.

No-Blink Fluorescent Switch

A NEW no-blink starter switch which will end a fluorescent lamp's life when it has reached the stage where it blinks on and off has just been announced by the commercial engineering department, Westinghouse Elec. & Mfg. Co., Bloomfield, N. J.

Designed specifically for the 40-w. Mazda fluorescent lamp, the new switch will eliminate blinking and flickering of burned-out lamps, starter switches will last longer because they will not be impaired by repeated attempts to start lamps. The "no-blink" switch makes the group replacement idea feasible when lamps are installed in inaccessible places.

The new switches are to be interchangeable with present FS-4 two-contact switches for operating 40-w. Mazda F lamps. They will be available in October in limited quantities. Orders from defense industries will be given preference and other orders will be filled as production increases. The no-blink switch will be more expensive to manufacture and thus will sell for more than the present FS-4 switch.

To lessen inconvenience and irritation to workers in noisy locations, Mine Safety Appliances Co., Pittsburgh, Pa., announces its Ear Defenders, made as tapered moulded tubes of soft rubber, with inner barrier of soft rubber and outer of metal, separated by an air space. The device is easily inserted and removed from the ear without danger of contact with the ear drum and is designed for easy cleaning with soap and water.

THE HARD WAY

Replacing damaged boiler tubes, which have failed prematurely due to scale formation, is really the hard way . . . and expensive, too!

FOR SCALE-FREE BOILER TUBES

USE THIS EASY LOW-COST WAY

Dearborn treated water prevents scale formation, thus eliminating the frequent cause of tube failure. Labor and material are not the only costs that accumulate every time damaged tubes require replacement caused by excessive scale condition. The loss of boiler horsepower due to shutdowns for repairs may well be more costly and of greater concern in these days, when production is pushed to the limit. This avoidable cost and loss of boiler horsepower can be prevented by using Dearborn Water Treatment and Engineering Service.

Dearborn Water Treatment eliminates scale trouble and provides full protection against pitting and corrosion; Dearborn Engineering Service takes the necessary steps to determine and correct the causes of steam contamination. Send for a Dearborn engineer. He will make a complete survey of your plant. Water samples will be laboratory tested . . . then a treatment recommended to meet your individual requirements, followed by a systematic test procedure and frequent check-ups to insure uninterrupted, efficient boiler operation.

THE DEARBORN WAY

Dearborn treated boiler water can't scale. No scale . . . no expensive tube replacements . . . no time-consuming boiler shutdowns. That's the low-cost easy way!

DEARBORN CHEMICAL COMPANY

Dept. F, 310 S. Michigan Avenue — Chicago, Illinois

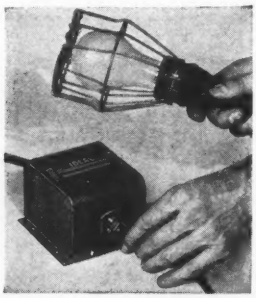
TRADE MARK REGISTERED

Dearborn WATER TREATMENT

AND ENGINEERING SERVICE

Lo-Volt Transformer

FOR WORKMEN using electrical extensions in damp, all metal or otherwise hazardous locations this low-voltage transformer is announced by the Ideal Commutator Dresser Co., Sycamore, Ill. It consists of a step down transformer, plugged in between the power supply and



the extension to reduce the extension voltage to 6 v., thus eliminating danger from shock due to bad sockets or defective extension cords.

Transformer has a 10 ft. three-conductor safety type primary cord; capacity is 50 watts with a 25 ft. extension. Longer extensions require proportionately lower watt lamps. Available for 110 v., 60 or 25 cycle.

Gas-Filled Cable

LOW-PRESSURE gas-filled cable combines the advantages of oil-filled cable with the low cost and simplicity of solid-type cable and offers a new means for safeguarding power supplied to defense industries. Gas-filled cable is a new development, although installations totalling 140,000 ft. have been made, according to V. A. Sheals in a paper before the A.I.E.E. and the Louisiana Engineering Society. It is housed in a lead sheath filled with dry nitrogen at a pressure of 10 to 15 p.s.i. Any damage to the cable sheath sufficient to cause a leak lowers the pressure and sets off an alarm at the power station, so that the leak can either be investigated immediately and repairs made to avoid service failure, or, if the leak is small, additional gas can be fed into the cable from standby high-pressure cylinders and repairs postponed until a more convenient time.

Logical field of application is for important tie lines and feeders at voltages from 10 to 40 kv., the gas-filled type standing maximum loads without deteriorating.

Pressure maintenance has proved important in oil-filled cable, hence was the foremost consideration in designing the new type cable. Gas was selected as the pressure medium because it appeared to be the simplest to establish and maintain. Dry nitrogen with a negligible amount of oxygen was selected as the best gas to prevent oxidation or other chemical deterioration.

Cable is shipped from the factory with a gas pressure of about 8 to 10 lb., and this pressure is checked in the field when the cable is received.

Joints, terminals, pressure relays, and pressure-regulating equipment, are simple in design. Stop joints are not needed because there is no head pressure with gas-filled cable. For convenience of repair work, runs of more than 40,000 ft. can be segregated into sections by incorporating a semi-stop at one end of the normal joint.

Simple pressure relay is attached to one or both ends of the line, and gives an alarm if the pressure of gas in the cable drops below 10 lb. or rises above 15 lb. Pressure control is maintained manually from the high-pressure gas storage cylinders normally shut off from the line. Gas volume in the cable is sufficient to take care of daily load-temperature cycles, and readjustment for seasonal ambient temperature is necessary only twice a year. Excessive gas pressure in the cable is brought down by venting.

First gas-filled cable lines were installed in 1938 on the systems of the Yonkers Electric Light & Power Co. and the Consolidated Edison Co., both rated 15 kv. and were three-conductor 800,000 c.m. with 150 mils insulation. Since that time the latter company has installed additional runs of the cable at both 15 and 27 kv. Last year the Hartford Electric Light Co. installed a 16,000-ft. feeder operating at 27 kv. to supply power to various defense industries.

Decade Capacitor

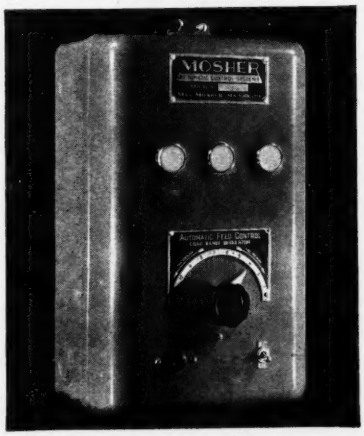
CHOICE of any capacity value from 0.01 to 11.1 mfd. in 0.01 mfd. steps, or other ranges, by the turning of three knobs, is provided by the Decade Capacitor Type DK offered by Industrial Instruments, Inc., Jersey City, N. J.

Attractive walnut cabinet has hinged cover and snap lock. The etched metal panel has three dials calibrated directly in capacitance, so that reading from left to right totals up the value available at the binding posts. Three models are available: 11.1 total in .01 mfd. steps; 1.11 mfd. in .001 steps; and 1.11 in .001 steps with mica dielectric throughout.

Electronic Control for Pulverizers

TO CONTROL feed to pulverizers, an electronic robot announced by Industrial Instrument, Inc., Jersey City, N. J., gives great accuracy and economy. The Mosher Automatic Control available in New York, N. Y. and St. Louis, Mo., safeguards against clogging due to variations in material or moisture content and so prevents overheating and motor burnouts from overloading.

Control unit in a steel case connects to a magnetic contactor switch of the 1- to 5-hp. feeder motor. The control is set for full load current by adjusting with an ammeter in circuit. Special current transformer is adjusted for full load current of the motor, which is so interlocked that the feeder motor cannot be started until the grinder motor is operating. White signal light indicates that the control is in operation. The regulator has a range from 50 to 125 per cent of full load on the grinder motor.



If load on the mill exceeds full load, controller will cut off the feeder motor automatically and a red light shows. When the mill has cleared the overload, feeder motor cuts in and red light goes off. Steady red light for over 30 sec. requires investigation of the cause of the overload.

Green light indicates load under 25 per cent of full load, and that material is not reaching the grinder.

The equipment is for grinders up to 250-hp. and feeder of 5-hp., standard voltage 550 but can be made special for up to 2300 v. Control unit operates on 110 v., 60 cycles.

Stabilog Controller

NEW MODEL 30 controller, recently announced by the Foxboro Co., Foxboro, Mass., which has a convenient rectangular case, extends only ¾ in. from the panel surface and has a recessed door with hinges and hasp flush with door surface. Dual pressure indicator is visible through a rectangular opening, with interior illumination, if desired. Operating adjustments are made from the front when the door is opened, operating mechanism being protected by a removable plate. Operating features are a proportional function, a reset function to give stabilization at the desired point of control, and a temporary correction function for disturbance of conditions, which is automatic, governed by the proportional and reset adjustments.

Sponge rubber made from the synthetic rubber, Amerpiol, is a new product of the B. F. Goodrich Co., Akron, Ohio, developed to fill requirements of a wide range of applications where oil, grease or other solvents which deteriorate natural rubber rapidly are present. The new Amerpiol synthetic sponge rubber is in the same manufacturing classification as milled sponge made from natural rubber. Sodium bicarbonate or a similar blowing agent is turned into gas by the heat of vulcanization and thus produces a cellular structure.

LOOK "INSIDE" BEFORE YOU BUY MECHANICAL-DRIVE TURBINES

BECAUSE, that's where the difference shows up—vital differences in sustained economy, continuous service, and operating safety. So we've "opened up" the steam chest of the improved Type D mechanical-drive turbine for your inspection and comparison. You'll find double safety here—safety against overspeed and safety against lost operating time, costly shutdowns, and high maintenance cost. You'll find a balanced-pressure governor valve that responds quickly to small changes in speed. And, you'll find a hand speed changer that enables you to operate the driven equipment at its most efficient speed.

1. EASILY ACCESSIBLE STEAM STRAINER

The steam strainer is ahead of both the trip and governor valves to prevent foreign material from entering and damaging any part of the turbine. Full steam flow with no pressure drop is assured by designing the strainer with 200 per cent more open area than the inlet. The strainer can be easily removed for cleaning without breaking the station piping.

2. COMBINED TRIP AND THROTTLE VALVE

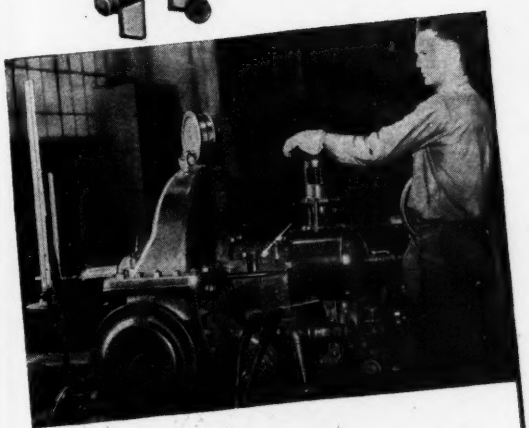
The combined trip and throttle—a standard feature of the improved Type D—admits steam to the turbine and assures protection against overspeed. The valve is spring loaded and, when tripped by the overspeed governor, is closed instantly against all steam flow by both spring force and steam pressure. After tripping, the valve can be reset at the turbine without shutting off the main steam supply. The valve chamber is designed for the least possible resistance to steam flow.

3. BALANCED-PRESSURE GOVERNOR VALVE

Steam, after leaving the throttle valve, enters the nozzles around and through the balanced-pressure, double-seated throttle operating in renewable seats. V-notches form guides on the valve disk to add two additional points of support for the stem. The valve trim is of chrome-iron alloy to assure long wear and resistance to corrosion and erosion. No soft packing is used where the valve stem extends through the valve support. Instead, three accurately machined bushings, with an intermediate leak-off connection, prevent leakage of steam. This construction eliminates stem packings and assures free valve action.

4. HAND SPEED CHANGER

A hand speed changer can be built into the governor linkage to provide a 20 per cent speed adjustment while the turbine is in operation. This is always required on dual-drive applications, and recommended in order to operate the driven equipment at its most economical speed. For further details, write or phone your nearest G-E office. General Electric, Schenectady, N. Y.



EVERY General Electric Type D turbine must pass a complete operating test under steam to provide advance proof of its performance. This running trial is for making adjustment of the speed governor, setting the overspeed trip, checking smoothness of rotation, and testing packing glands and steam joints. Attention to these details makes it a short time from shipping crate to on-the-job operation.

GENERAL ELECTRIC

Visibility

PLUS UNIFORM ACCURACY

Have you ever had a gauge glass break almost immediately after you installed it? If you have, it was probably due to installation strains which are the result of a slightly oversized glass.

To overcome these strains, PYREX and Corning Gauge Glasses are machine drawn to uniform accuracy.

In addition, PYREX Broad Red Line Gauge Glasses have these outstanding economy features: Resistance to the chemical attack of hot water and steam, resistance to heat and cold shocks, and visibility from greater distances. Ask your dealer for complete details. PYREX and Corning Gauge Glasses are stocked by leading steam and mill supply houses.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Change of Address

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

Grinding Wheel Dresser

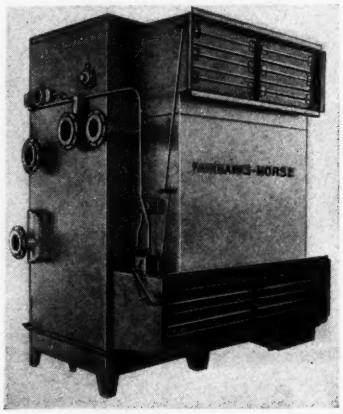
IN THIS abrasive-wheel-type grinding wheel dresser, made by Ideal Commutator Dresser Co., Sycamore, Ill., the cutting wheel is held in a protective metal housing which deflects the grindings away from the operator. Large handle and cutting wheel replaceable make it convenient for use and maintenance.

Besides general cleaning and truing of a grinding wheel, it can also be used to shape wheels into different forms when form grinding is desired.

Evaporative Coolers

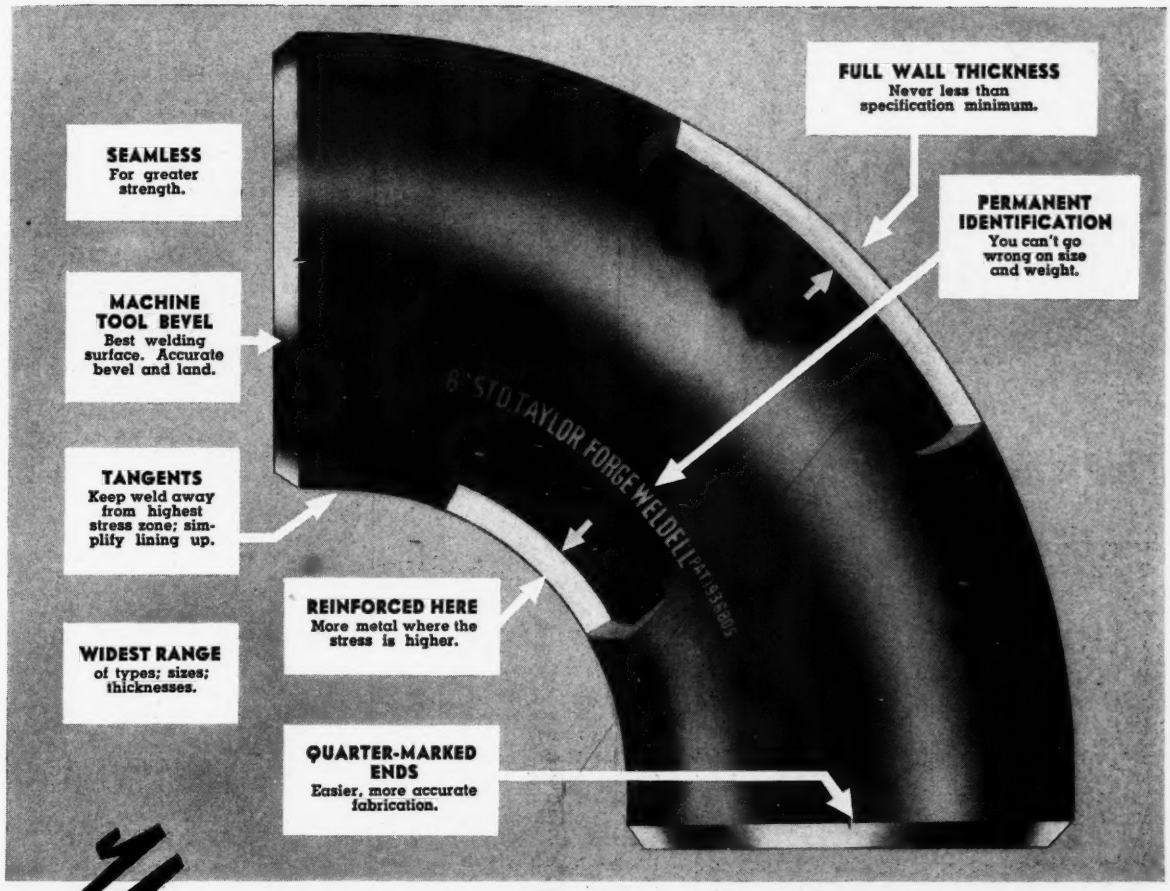
NEW AND improved models of Diesel engine jacket water coolers of the evaporative type have been developed by Fairbanks, Morse & Co., Chicago, Ill.

This device consists essentially of a coil through which the jacket water is passed, nozzles to spray water on the coil and a blower to force air past the coils. In operation, the hot jacket water enters the cooling coil at the top of the cooler, water from the reservoir at bottom of unit is sprayed over the soil from one end and air is blown in from the other end.



The cooling process is the result of the water spray over the outside coil in the opposite direction to the flow of induced air. The heat of the jacket water is absorbed by the air through direct transfer and by evaporation of water on the coil surface. After being cooled, the jacket water is then returned to the engine. The spray water is constantly recirculated so that the active amount consumed is only about 2 lb. per 1000 B.t.u. of engine heat absorbed.

Units are available which cool the engine lubricating oil in a separate coil within the same cooler as the jacket water. This simplifies piping and saves space. Three types of coolers are also built by the manufacturer, completely automatic, semi-automatic and manual.


SEAMLESS
For greater strength.
MACHINE TOOL BEVEL
Best welding surface. Accurate bevel and land.
TANGENTS
Keep weld away from highest stress zone; simplify lining up.
WIDEST RANGE
of types; sizes; thicknesses.
FULL WALL THICKNESS
Never less than specification minimum.
PERMANENT IDENTIFICATION
You can't go wrong on size and weight.
REINFORCED HERE
More metal where the stress is higher.
QUARTER-MARKED ENDS
Easier, more accurate fabrication.
8" STD TAYLOR FORGE WELDELL

Yes, WeldELLS have everything

"PEOPLE don't buy *names* today", comments a business publication, "they buy *products*". And that suits us perfectly as a basis for judging the merits of WeldELLS and other Taylor Forge Welding Fittings.

As for a name, none is more distinguished in the field than Taylor Forge. But we expect our products to stand on their own merits.

That's why we invite your comparison of WeldELLS, point by point, with any other make of welding fittings—why we say, as we have said in effect many times before: Consider the product—consider the features—the *eight extra-value* features illustrated here that are combined only in WeldELLS.

It would be idle to contend that any one of these features is absolutely vital to a good job of welding, *but*—

—who can say that a job welded with fittings which lack *any* of these features does not sacrifice *something*—in ease of installation, in economy, in safety, in the lasting satisfaction that goes with using the best there is?

With all their plus-features WeldELLS cost no more. Make that your final reason for using the welding fittings that have—*everything*.

• • •

Complete information and valuable engineering data are covered by Taylor Forge Catalog 401. Ask for it today.

TAYLOR FORGE & PIPE WORKS General Office & Works: Chicago, P.O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Building

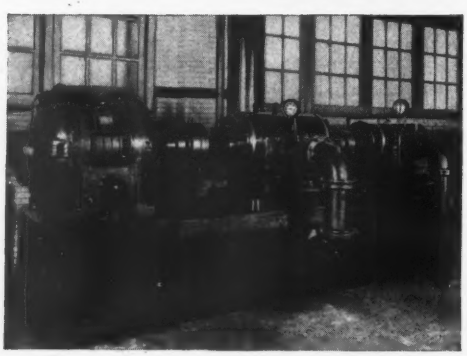
FULLER ROTARY COMPRESSORS

for

PRESSURES TO 125-LB.

Based on facts . . . Proof that Fullers are 80 to 125-lb. service units.

750 C.F.M. each, actual free-air delivery, **100-lb. pressure** Two-stage Rotary Compressors, installed early 1935 in a cement plant in Pennsylvania. This plant is equipped exclusively with Fuller Rotaries, a total of seven installed. All of these machines have fine performance records with low maintenance costs. During six years of operation the company has spent only $383.89 for repairs, an average of $9.14 per machine, per year. This record speaks for itself.



1000 C.F.M. actual free-air delivery, **100-lb. pressure,** Two-stage Rotary Compressor, installed April, 1934, in a food products plant in Illinois.

Write for Bulletin C-3A

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

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C-51

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

V-Belts

STANDARD construction V-belts have in the past been recommended by The B. F. Goodrich Co., Akron, Ohio, only for operation in temperatures under 130 deg. F. Specially compounded heat-resisting V-belts were furnished for temperatures above 130 deg. The company now announces that as a result of development and research it has been able to increase the heat-resisting qualities of its standard V-belts so that they are now fully equal to the special black heat-resisting belts. The special black heat-resisting construction is discontinued and the standard belts can be ordered from stock for drives on which the heat-resisting belts have previously been necessary.

Time Relays

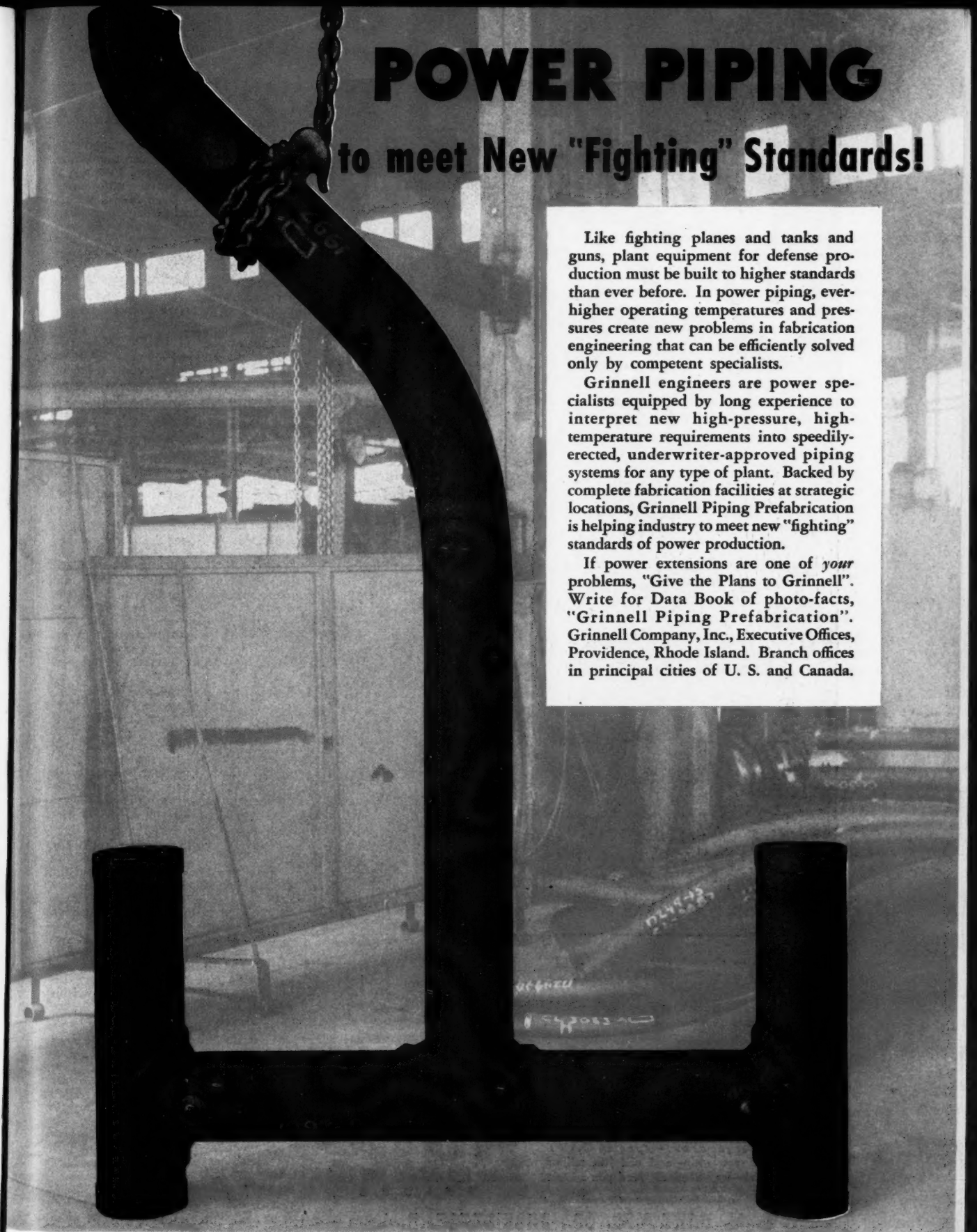
CRAMER time relays for holding an electric circuit closed for a determined time or for time delay to keep a circuit open for a selected interval are offered by R. W. Cramer Co., Inc., Centerbrook, Conn. They are synchronous-motor operated, repeat timing without resetting, or can have inbuilt or remote control manual start button. Micrometer adjusting knob with worm gear provides close adjustment on a visible scale, a pointer showing what part of the cycle has elapsed and time before the switch will trip. Contact can be operated manually at any time by turning the adjusting knob. Main switch capacity is for 10 amp. at 115 v., 5 amp. at 220 v., or 3 amp. at 440 v. and will operate a ½ hp. motor, 1000-w. heater or 250-w. lamp load.

Blackmer Duplex Pumping Units with 50 g.p.m. capacity per unit, or 100 g.p.m. with two units operating simultaneously have been recently announced by Blackmer Pump Co., Grand Rapids, Mich. Swinging-vane Blackmer buckets, streamlined inlet, built-in relief valves, removable liners, steam-jacketed heads are among the features offered. Uses are specially for refineries, tar, printing inks and other viscous materials. For 100 p.s.i. with lubricating liquids or 75 p.s.i. for non-lubricating. Mounted on bed plate, with motor or gasoline engine, gear case and clutch.

Primoid Standard, manufactured by Primoid Products Corp., New York, N. Y., is a new waterproofing compound which is an effective seal for concrete, brick, stone and other types of masonry, as well as for wood and composition materials. It is a clear rubber-base liquid which can be either sprayed or brushed on, penetrates deep into the pores of the material to be waterproofed, effectively sealing the surface, and adheres permanently, spite of heat or cold. Colors, dry or ground in oil, can be mixed with Primoid Standard, which can also be used as a coating for iron, steel and other metals, to prevent corrosion.

A new model, streamlined, more compact Super Sight has been recently announced by the Boyer Campbell Co., Detroit, Mich.

Introduced a year ago for first aid work, the new bracket is used for removing particles from eyes, splinters from fingers, etc. An older model is still the choice where a magnifying glass with a larger field is desired and where space is not at a premium. Both models give magnification and light where you want them.



POWER PIPING

to meet New "Fighting" Standards!

Like fighting planes and tanks and guns, plant equipment for defense production must be built to higher standards than ever before. In power piping, ever-higher operating temperatures and pressures create new problems in fabrication engineering that can be efficiently solved only by competent specialists.

Grinnell engineers are power specialists equipped by long experience to interpret new high-pressure, high-temperature requirements into speedily-erected, underwriter-approved piping systems for any type of plant. Backed by complete fabrication facilities at strategic locations, Grinnell Piping Prefabrication is helping industry to meet new "fighting" standards of power production.

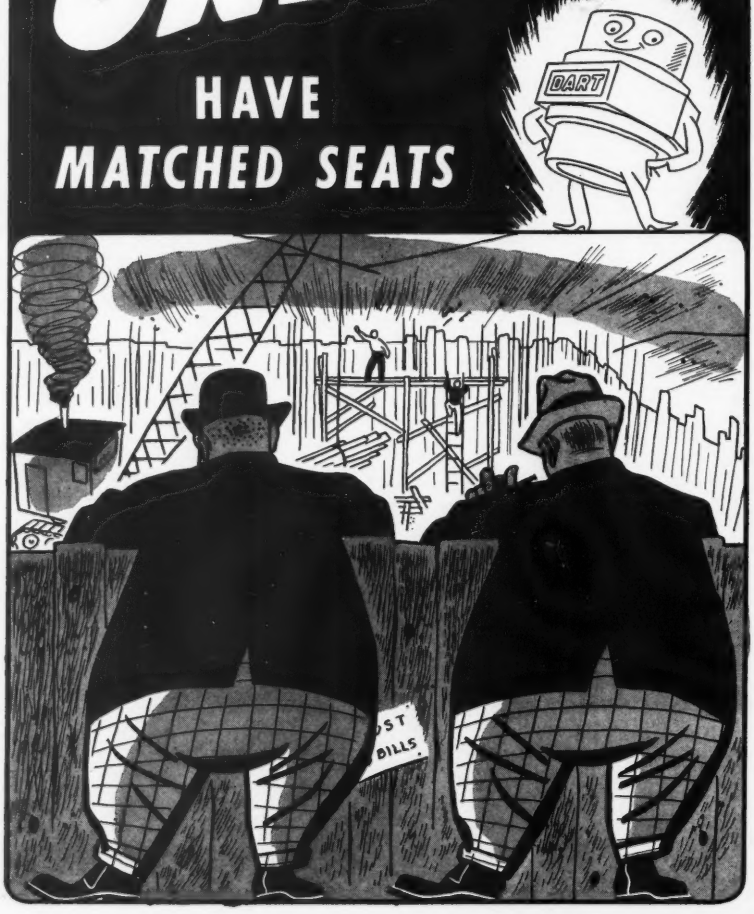
If power extensions are one of *your* problems, "Give the Plans to Grinnell". Write for Data Book of photo-facts, "Grinnell Piping Prefabrication". Grinnell Company, Inc., Executive Offices, Providence, Rhode Island. Branch offices in principal cities of U. S. and Canada.

PREFABRICATED PIPING BY **GRINNELL**

WHENEVER **PIPING** IS INVOLVED

DART UNIONS

HAVE MATCHED SEATS



...to Give Unmatched Performance

One of the big reasons that Dart Unions make up tight the first time, quickly and easily—stay tight longer—and can be re-installed so many times is due to the fact that they have matched bronze seats, ground to accurate "true-ball" surfaces. *Another* big reason for the complete satisfaction that Dart Unions give is that their bodies and nuts are made of air refined malleable iron that resists pipe strains and wrench abuse.

Now—when pressure on production is so high and you need equipment that you can install easily and *forget about*—specify DART UNIONS. If you wish—and will just tell us size and model—we will gladly send you a Dart to try free.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

MANUFACTURERS' PERSONALS

V. L. Francisco has been appointed General Sales Manager for the Water Treatment Co. of America, Pittsburgh, Pa., on Baerite feed water conditioning. Mr. Francisco has been consultant on boilers, heat exchangers, power plant equipment and water conditioning with Whitelock Manufacturing Co. and other leaders in the power equipment field.

George Volkmuth of 119 Blaine Street, Syracuse, N. Y., is distributor in that area representing the Water Treatment Co. of America.

Appointment of Earl C. Maund in a sales and engineering capacity in its Chicago Office has been announced by Manning, Maxwell & Moore, Inc. of Bridgeport, Conn. Mr. Maund's engineering services will cover the handling of Consolidated Safety Valves, Hancock Valves, American Instruments and Ashcroft Gauges.

Mr. Maund was formerly in an engineering capacity with the Sinclair Refining Co. at East Chicago, Indiana, and with the Cities Service at Shreveport, La.

Dr. H. A. Jones has been named manager of sales of General Electric electronic tubes for nonradio applications in industry, according to an announcement by Dr. W. R. G. Baker, manager of the Radio and Television Department, the industrial tube division having been transferred from the Special Products Section of the Industrial Department to the Radio and Television Department.

Dr. Jones, a graduate from Pennsylvania State College, and from Princeton in 1922 as a Doctor of Philosophy, joined the General Electric Co. in 1922 in the research laboratory, and in 1928 was transferred to the Commercial General Section, selling special products developed in the G-E laboratories for use throughout industry, becoming manager of this Special Products Section.

Taylor Instrument Co., Rochester, N. Y., announces the appointment of Wallace W. Lockwood as Advertising Manager to succeed Elmer E. Way, who has resigned. A graduate of Auburn High School and Syracuse University, Mr. Lockwood joined the Taylor Advertising Department in 1932 and was made Assistant Advertising Manager in 1939. Previously he was connected with the Lapp Insulator Company, Leroy, N. Y., the Z. L. Potter Advertising Agency and the David Tynion Advertising Agency, both of Syracuse.

Ray P. Tennes, for the past 7 yr. a Director and Secretary-Treasurer of the Shafer Bearing Corp., has been elected Chairman of the Board of Directors, to succeed his father, the late M. J. Tennes, who was Chairman of the Board since 1930. In addition, Mr. Tennes will continue as Treasurer. W. L. Kinnaw, Comptroller of the Corporation, has been elected Assistant Treasurer-Assistant Secretary.

M. J. Tennes, Jr., President of the Corporation, is now on leave of absence, serving as Captain in the U. S. Army Air Corps.

(*Continued on Page* 119)

THIRD "S-A" STEAM GENERATOR

for prominent manufacturer of electrical equipment

INITIAL INSTALLATION

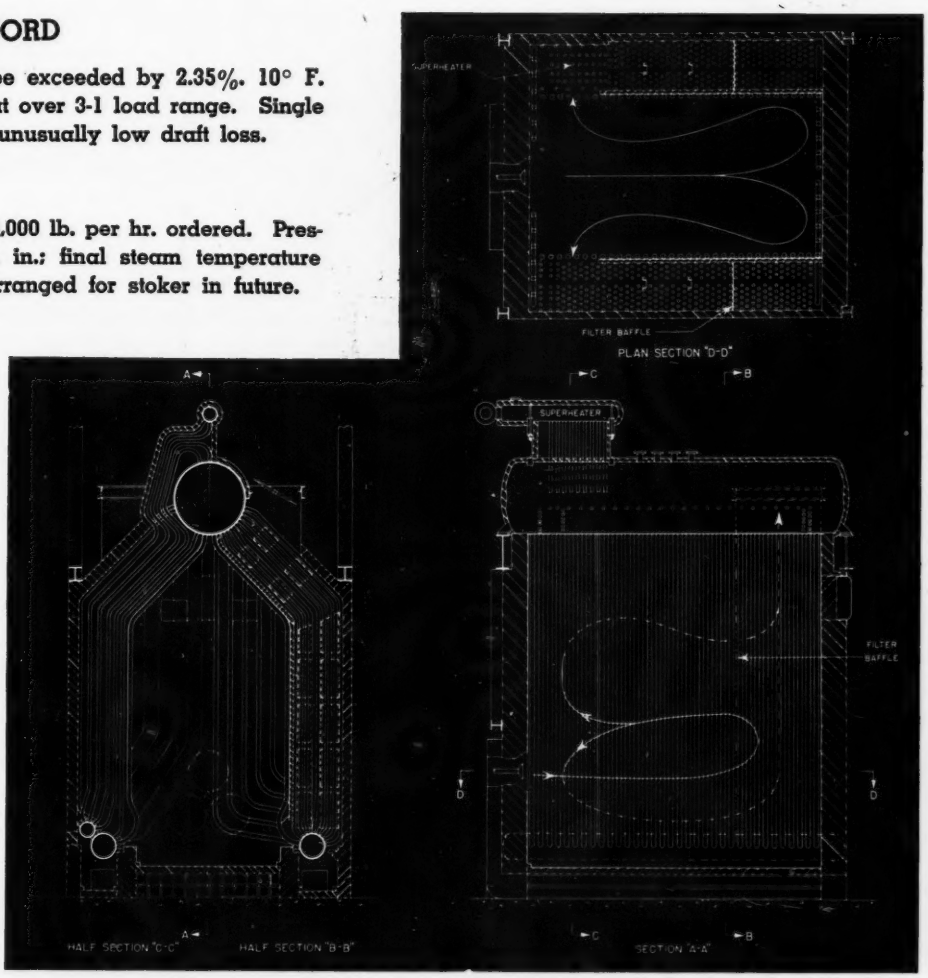
Two 60,000 lb. per hr. oil fired "S-A" steam generators; 260 lb. per sq. in.; 452° F. final steam temperature; as shown.

OPERATING RECORD

Efficiency guarantee exceeded by 2.35%. 10° F. variation in superheat over 3-1 load range. Single pass gas flow gave unusually low draft loss.

RESULT

A third unit for 150,000 lb. per hr. ordered. Pressure 650 lb. per sq. in.; final steam temperature 850° F. Oil fired; arranged for stoker in future.



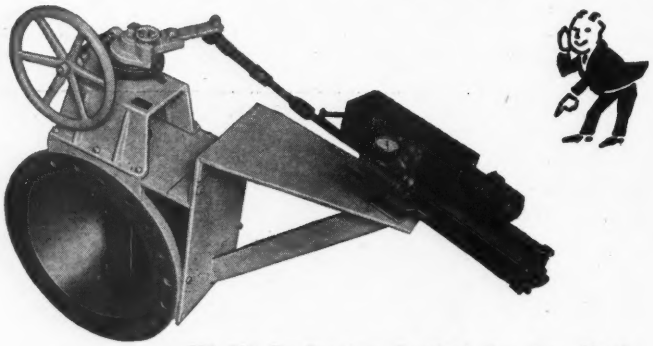
Above: Reverse firing assures complete combustion; staggered tubes with cross gas flow give high efficiency.

FOSTER WHEELER CORPORATION, 165 Broadway, New York

FOSTER WHEELER

ADVERTISING PAGES REMOVED

SHUT-OFF and CONTROL with STREAMLINED SIMPLICITY



20" 125 lb. American Standard Cast Iron, Hand Wheel and Hydraulic Cylinder Operated, Ball Bearing Mounted. Mechanism is Equipped with Declutching Unit for Operation with the Manual Hand Wheel Control or the Hydraulic Cylinder. For Hydraulic Service at 125 Pounds Working Pressure.

R-S Butterfly Valves are designed for positive shut-off and control of any medium that flows or is forced through a pipe, under a wide range of pressures as well as high and sub-zero temperatures. For high pressure steam lines, cast steel valves are recommended.

Erosion and corrosion conditions are met by special linings or special metal alloys. Positive shut-off is provided by accurate machining and the angle of closing of the vane against the body of the valve. This combination of conditions produces a wedge-tight closure.

Furthermore, R-S Butterfly Valves are simple, compact, and mechanically correct. There are no right angle bends or reverse turns to restrict the flow or collect sediment. Consider also, the low first cost, low installation cost and minimum maintenance.

Write for Bulletin 8-B or consult with our representative in your city.

R-S PRODUCTS CORPORATION
4535 Germantown Ave., Philadelphia, Pa.

R-S BUTTERFLY VALVES

Precision Machined and Wedge-tight.

H. R. Bristol of the Chicago office of The Bristol Co. has been transferred to the Boston office at 250 Stuart St. J. E. Booth has been appointed to take over the territory in Chicago district, formerly covered by Mr. Bristol.

Link Belt Co. announces the appointment of William A. Craig as Purchasing Agent of the company's Philadelphia plant, to succeed James C. Lenahan, who died recently at Somers Point, N. J. Mr. Lenahan a Link-Belt employe for 36 yr., had been Purchasing Agent since 1918. Mr. Craig joined Link-Belt in 1916 in the Philadelphia plant purchasing department. As assistant purchasing agent, he had been Mr. Lenahan's direct assistant for many years.

G. K. Viall, Vice President of Chain Belt Co. of Milwaukee, has been appointed as head of a new Division of Research and Development now being organized by the Company. Mr. Viall has been connected with Chain Belt Co. since 1921 in various capacities. In assuming his new position, he will also retain his position as Vice President in charge of the Construction Machinery Division.

Ric-Wil Co., Cleveland, Ohio, announces the appointment of Fred Belser as General Manager of the company. Mr. Belser, a graduate of Case School of Applied Science in 1916, has been associated with this company since 1928. The Ric-Wil Co. has also appointed to the position of Publicity Director, A. V. DeFosset, who comes from a previous position as Assistant Advertising Manager of the Seiberling Rubber Co. Mr. DeFosset, a graduate of The College of Commerce of Ohio State University, has had experience in several retail establishments, and for a time operated his own advertising agency in Columbus, Ohio.

The Johnston & Jennings Co., Cleveland, Ohio, has announced the appointment of five additional Stowe Stoker representatives, as follows: Murray G. Day, 201 Devonshire St., Boston, Mass.; W. H. Edwards Engr. Co., 2347 Winthrop Ave., Indianapolis, Ind.; George W. Hoyns, 136 Liberty St., New York, N. Y.; Henry J. Kaufman, 20 N. Wacker Drive, Chicago, Ill.; Kent-Ervin Engr. Co., Builders Exchange Bldg., Minneapolis, Minn.

Edgar F. Heckert has been appointed special assistant to the general works manager of the York Ice Machy. Corp., having been advanced from his previous position as manager of the service department. He was born in York, Pa., in 1886, obtained a B.S. degree in electrical engineering at Pennsylvania State College and joined the York organization in 1909.

R. I. Parker is now Assistant District Manager of the General Electric Company's Central District covering the Chicago district. A graduate of the University of Kansas in 1912 Mr. Parker joined the General Electric Co. as a test student at the Schenectady Works, and in April, 1913 entered the Lighting Engineering Department. He joined the sales force of the Chicago Office in 1919 becoming Assistant Manager of Apparatus Sales in 1921, and District Manager of the Central Station Department in 1924, which he will continue to handle.

W. J. Dorworth is now Assistant District Manager of the General Electric Co.'s Atlantic District as announced by O. K. West, Commercial Vice President. Mr. Dorworth entered General Electric's test course at Schenectady in 1904 and in 1906 was transferred to the Philadelphia Works as foreman of the construction force. In 1912 he was assigned to the Industrial Sales force in Baltimore, and was appointed Manager of the Industrial Department of the Atlantic District in 1923.

Richard J. Connor has been appointed general counsel of Federal Power Commission in place of William S. Youngman Jr. who has resigned. Mr. Connor has been with the Commission since 1937, the past 3 yr. as assistant general counsel.

Downingtown Iron Works of Downingtown, Pa., near Philadelphia, has recently set up a division for the manufacture and design of heaters, coolers and condensers, this Heat Transfer Division to be housed in its own building. Manager of the new division is R. M. Armstrong, in charge of design and sales of the new products; assisting is F. J. O'Sullivan. Dr. T. H. Nelson will collaborate on problems involving unusual metallurgical problems.

Blaw-Knox Appoints New Vice President

Edwin A. Wert

BLAW-KNOX Co. announces the appointment of Edwin A. Wert as vice president in charge of engineering and sales of its Power Piping Division. Mr. Wert takes the position held by S. J. Horrell, has been a consultant for the company for a number of years, and comes from the Detroit Edison Co., where he has been engaged in an engineering and design capacity for 18 yr. In his work on piping design, he recently developed, in behalf of Blaw-Knox Co., simplified formulas for determining the stresses in power piping systems. He is an alumnus of the University of California, was an instructor in the U. S. Air Corps during the last war, is a member of the American Society of Mechanical Engineers, and has served as a lecturer at the Detroit Institute of Technology.

O'Brien Elected J-M Vice President

John A. O'Brien

ELECTION of John A. O'Brien to the post of vice president of Johns-Manville Sales Corp. was announced on October 1st by Lewis H. Brown, president. Mr. O'Brien will continue his duties as general sales manager of the power products and industrial department, a post he has held since 1938. He is a member of the J-M Quarter Century Club, having begun his career with the company in 1915, and is a member of the Engineers' Club, New York.

Take Time to Test

Now is no time for electrical insulation failures that can tie up production. Wise maintenance programs regularly schedule brief "time-out" for testing the insulation of all important machines, cables and control equipment.

And of equal importance in many installations are measurements of ground connection resistances, for safety, and to avoid trouble due to lightning and other system disturbances.

Biddle Bulletins on Preventive Maintenance

- *Pocket Manual of "Megger" Practice No. 1420 PE*
- *On the Use of Hand Driven "Megger" Testers, Bulletin 1655*
- *Ground Resistance Testing, Tech. Bulletin 1285*
- *"Ducter" Ohmmeter (used on Circuit Breakers) Bulletin 1635*

When writing, please mention this Advt. No charge.

The above picture is by courtesy of the Hartford Steam Boiler Inspection and Insurance Co. This and other large Insurance Companies protect their risks—and your plant—by systematic inspection and testing, in which our "Megger" Instruments play a fundamental part.

These remarkable testers, with self-contained hand-cranked generators, have served industry for more than 35 years. You make no mistake when you select them.

JAMES G. BIDDLE CO.
1211-13 ARCH STREET • PHILADELPHIA, PA.

"MEGGER"
TRADE MARK REGISTERED U.S. PAT. OFF

Modern cleaners for modern boiler tubes

In modern boilers there are tubes everywhere, — floor tubes, roof tubes, side wall tubes, screen tubes, baffle wall tubes, etc. These tubes are full of bends and curves (some on very short radius). Many are quite long (60 to 125 feet). Some are swedged down from one size to another. Several sizes of tubes are used in one boiler.

But modern boilers are like old timers in that the tubes must be cleaned occasionally. We furnish cleaners to the biggest central station plants and for the very latest types of boilers. If a tube is accessible so that a cleaner can be inserted, we can furnish the cleaner which will do the work.

Whether your boilers are up-to-the-minute or twenty-odd years old, Lagonda-Liberty cleaners have the proper types of motors and cutter heads, and the operating hose to do their work well and quickly.

Lagonda-Liberty cleaners are up-to-the-minute in design, and in the use of modern improved metals and heat treating methods. They do a quick and thorough job.

ELLIOTT COMPANY

Lagonda-Liberty Tube Cleaner Dept.

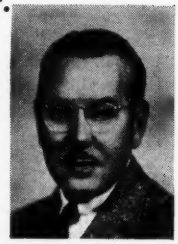
SPRINGFIELD, OHIO

District Offices in Principal Cities

Y-164

LAGONDA LIBERTY TUBE CLEANERS

H. S. Pahren Advanced to Dept. Mgr.



H. S. Pahren

ELLIOTT Co. on September 1, placed H. S. Pahren in the position of manager of its Electric Power Sales Department. His headquarters are the Ridgway, Pa. Works of the company, and his jurisdiction covers the Elliott line of motors, generators and electromagnetic couplings.

Mr. Pahren attended public school in his home town, Cincinnati. He went to the University of Cincinnati as the first Westinghouse War Memorial scholar, graduating as electrical engineer. While at the University, he was also employed in the electric meter laboratory of the Union Gas & Electric Co. Upon graduation he went with Westinghouse Electric & Mfg. Co., working at East Pittsburgh, Sharon, Derry, and South Philadelphia Works. He was then sent to Cincinnati and later, to the Indianapolis office of Westinghouse, after which he was moved to Dayton, Ohio, as sales engineer in the central station division of that office.

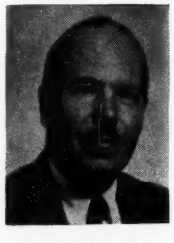
Later he was employed as electrical engineer in the Department of Public Utilities of the City of Cincinnati under the present director, Edgar Darrel Gilman. He came with the Elliott Co. in 1928 and has been located in the Kansas City, Omaha, Tulsa, and St. Louis offices. He had been district manager in St. Louis since 1936.

Jack W. Green

J. W. Green

TUBE - TURNS, INC., Louisville, Ky., has recently appointed Jack W. Green as manager of its Chicago office and the surrounding territory, handling Tube-Turn Welding Fittings and industrial piping.

J. H. Schenck



J. H. Schenck

THE DAMPNEY Co. of America, Hyde Park, Boston, Mass., announces the appointment of J. H. Schenck as manager of the Detroit office, succeeding Lieut.-Comdr. C. M. Boling, who is now on active duty with the Navy Department. Mr. Schenck goes to Detroit with a wide experience handling power plant equipment and Apexior in the Pittsburgh district.

Allis-Chalmers Personnel Change

WALTER E. HAWKINSON, treasurer of the Allis-Chalmers Mfg. Co. since 1936, was elected to the joint position of secretary-treasurer recently. He assumes the secretarial duties of Wm. A. Thompson, company vice president and secretary, who has resigned.

"COAL FOR ECONOMY"

. . . is the fuel choice in fourteen plants of

THE ELECTRIC AUTO-LITE COMPANY

FROM the many divisions of ELECTRIC AUTO-LITE, world's largest independent makers of automotive parts and appliances, pour out over 400 different products . . . standard equipment for nearly a hundred different makes of automobiles and trucks. A major objective of all these manufacturing operations is to be "constantly cutting costs without sacrificing quality." One proved economy, standard in Electric Auto-Lite plants, is the use of modern, prepared COAL. On a basis of fuel costs, high efficiency and low maintenance and steam costs, "For our purposes," says the engineer in charge, Mr. W. E. Whalen, *"we find COAL the most economical of fuels."*

PERHAPS WE HAVE THE ANSWER TO YOUR POWER PROBLEM

To help industrialists lower the cost of producing power and heat, Chesapeake and Ohio Lines maintains a staff of Fuel Service Engineers. These trained and experienced men act in advisory capacity . . . surveying power plants, consulting with plant engineers, suggesting ways to increase efficiencies. Their services are offered without charge or obligation. Would you like to have an economy study made in *your* plant? You have only to request it. Write to GEORGE H. REINBRECHT, Coal Traffic Mgr., Chesapeake and Ohio Lines, 2903 Terminal Tower, Cleveland, O.

IT PAY$ TO U$E MODERN . . .

Chesapeake and Ohio Lines

The new secretary started with Allis-Chalmers 34 yr. ago in the treasurer's department. In 1926 he became assistant manager of the Tractor Division, after which he played an important role in the rapid expansion of the company's agricultural trade. Returning to the treasurer's department in 1936, he was elected its head, a position he will now occupy jointly with his new office as secretary.

Mr. Thompson's resignation terminates 40 yr. of service at Allis-Chalmers. Beginning as a general bookkeeper in the Accounting Department of the company, he was later appointed chief accountant. In 1907 he was elected comptroller and in 1923 he was made secretary in addition. He relinquished the office of secretary when he was made a vice president in 1932, but again assumed the duties of secretary in 1936, retaining this office with the position of vice president until his recent resignation.

Robert Paxton, Mgr. of G-E Branch

APPOINTMENT of Robert Paxton as manager of General Electric's Philadelphia Works has been announced by W. R. Burrows, vice president in charge of manufacturing for the company. Mr. Paxton has been assistant to the late Philadelphia Works manager, R. V. Good, since October, 1940. He entered the company's Test course at Schenectady in 1923 following his graduation from Rensselaer Polytechnic Institute with an electrical engineering degree. The following year he was assigned to the switchboard department, in 1927 went to the Philadelphia Works as the first oil circuit breaker engineer, and was promoted to managing engineer of the metal-enclosed division in 1930. Following the consolidation of this division with the manual and automatic panel sections in 1932, Mr. Paxton became managing engineer of the panel and equipment division, serving in that capacity until his appointment as assistant to the works manager last year.

Branch Manager

R. M. Cundiff

BAILEY METER Co., Cleveland, announces the appointment of R. M. Cundiff as manager of its Cincinnati Branch office at 2512 Carew Tower Building, succeeding E. R. Dearborn whose resignation became effective August. 1. Mr. Cundiff, who is a mechanical engineering graduate of the University of Kentucky, has for the past 12 yr. been located in the company's New York branch office employed in application of metering and control equipment to steam power plants and industrial processes.

He will be assisted in his new position by Messrs. J. A. Lucas and J. E. Zimmerman, mechanical engineering graduates.

L. B. Neumiller Elected President

LOUIS B. NEUMILLER, who began his association with Caterpillar Tractor Co. of Peoria, Ill., 26 yr. ago as a stenographer and blueprint clerk in the engineering department, has been elected president of the company by the board of directors, succeeding B. C. Heacock, president since 1930, who becomes chairman of the Executive Committee.

From the engineering department in 1918 Mr. Neumiller moved into the factory to work on the various assembly lines, then returned to the engineering department where he became drafting room supervisor. In 1922 he was named parts manager and in 1931 was advanced to general service manager. He became sales manager for the central division in 1937, director of industrial relations shortly afterward, and was appointed a vice president of the company 5 mo. later. As vice president, a position he held until elevation to the presidency, Mr. Neumiller was in charge of the service, parts, industrial relations and training and public relations departments.

Mr. Heacock succeeds R. C. Force, who resigned as executive committee head, but remains a member of the board. Mr. Heacock will have headquarters in Peoria, although at present his time and attention are occupied in Washington, D. C., where he went last spring on a leave of absence to serve as special assistant to Under-Secretary of War Robert Patterson.

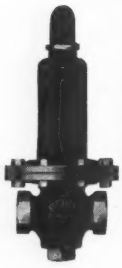
York Changes

FRED C. WOOD was recently appointed manager of the air conditioning department of the York Ice Machinery Corp.

Pressure Reducing Valves . . Back Pressure Valves . . Check Valves . . Atmospheric Relief Valves . . Steam Traps . . Drainers . . Air Traps . . Steam and Oil Separators . . Exhaust Heads . . Pipe Line Strainers . . Filters

FISHER CONTROL SPECIALTIES FOR YOUR PLANT REQUIREMENTS . .

No need to waste time shopping here and there for this and that control item — Fisher Governor Company Control Specialties are available in various types for all services, in all required sizes, for all pressure conditions. Just submit your requirements to Fisher and we will assume full responsibility for selecting proper equipment and guarantee satisfactory results. Shown here are only a few of the many Fisher Control Specialties available for your needs.



SELF CONTAINED REDUCING VALVE

For reduced pressure service on small volume installations. Suitable for air, gas, steam or non-corrosive liquid service. Maximum inlet pressure 250 lbs. Reduced pressure range 5 to 100 lbs. Available in sizes ¼", ⅜" and ½".

HIGH PRESSURE RELIEF VALVE

For all types of relief service on non-corrosive liquids and gases. Maximum fluid temperature 150° F. Relief pressure range 25 to 250 lbs. Furnished with bronze or iron bodies. Available in sizes ¾" to 1½" inclusive.

STEAM TRAP

A general service inverted bucket type steam trap applicable to every condensate draining installation within its pressure range. Suitable for maximum steam pressures up to 150 lbs. Available in sizes ⅜" to 1¼" inclusive.

FRE-FLO STRAINER

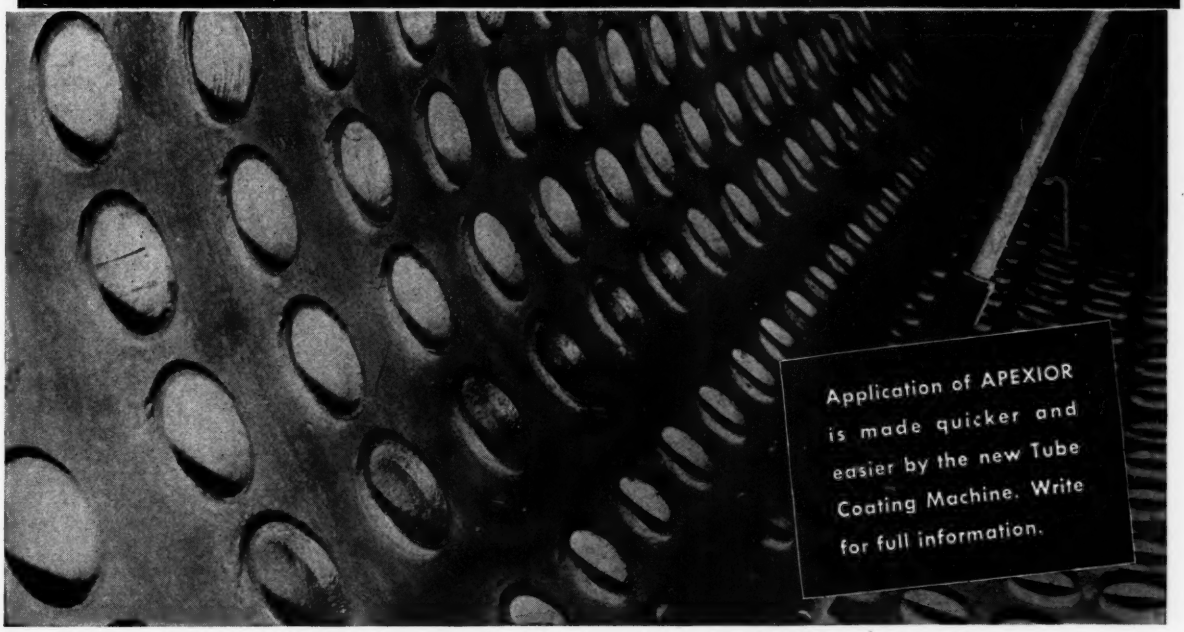
A "Y" type fre-flo strainer for installation on pipe lines carrying water, air, gas, oil, or steam. Protects automatic controls from foreign materials. Available in sizes ¼" to 6" for pressures up to 1000 lbs.

WRITE FOR CATALOG 35

FISHER GOVERNOR COMPANY
1005 Fisher Building
MARSHALLTOWN, IOWA

3 Times as Much Steam...

WITHOUT EXTRA WEAR ON BOILER METAL



Many boilers are being called on to supply steam around the clock — instead of on a one-shift basis as formerly.

You can get more positive protection against early corrosion of boiler metal... and eliminate extra cleanings that you would normally expect—by supplementing your water treatment with an APEXIOR coating.

Recommended by all U. S. and Canadian boiler insurance companies. Write for Bulletin 1290.

APEXIOR *will save you two ways:*

1. prevent corrosion in new boilers; effectively check it (after cleaning) in old boilers — for up to 3 years between renewals.

2. make boiler cleaning easier — and less often necessary — by preventing tight adherence of water scale.

Start the defense of your boiler metal now by applying APEXIOR. It will help your boilers stand up under extreme operating requirements. It may be the means of keeping in service certain old boilers otherwise due for replacement. It will certainly reduce outage periods for tube cleaning.

APEXIOR
REG U.S. PAT. OFF.

THE DAMPNEY COMPANY OF AMERICA

PROTECTIVE COATINGS FOR STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

HYDE PARK (Boston) MASSACHUSETTS

Atlanta · Chicago · New York · Detroit · Philadelphia

Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.

ROTO Tube Cleaners for DOUBLE BARRELLED ACTION

Model 135 motor with swing-frame head and air valve for one-man operation.

When you clean tubes with a new Roto, you get double barrelled action—faster action inside the tubes and faster action between tubes.

The powerful Roto motor, rugged, self-feeding heads and sturdy universal joints clean out the most stubborn scale faster than ever before possible with old type cleaners, and at great savings in upkeep cost.

In addition, Roto offers its exclusive labor saving one-man operating air valve which eliminates a helper and the starting and stopping delays due to signalling between operator and helper.

For fast, economical tube cleaning action such as you never got before, try the new Roto in your plant.

SEE OUR ADV. IN SWEET'S AND WRITE

The ROTO Company

145 SUSSEX AVENUE NEWARK, N. J.

Looking Ahead . . .

In the power field, perhaps more than in other basic industrial fields, the continuous betterments in machinery and methods compel men to look ahead with broader vision and greater determination than ever before.

Reading the advertising messages that appear in POWER PLANT ENGINEERING will keep you informed on new trends and opportunities. Month after month, these advertisements describe what's new in generating, transmitting power. They will help you and your plant join the onward march of the power plant industry.

Mr. Wood was born in Hamilton, Ohio, in 1905, graduated from Cornell and entered the York organization as a student engineer in 1928.

In line with the current trend to repair rather than replace, York recently organized a new sales depatment known as the Accessory Equipment and Maintenance Dept., which will include the personnel of the former service department and the former accessory equipment and supplies division. This newly created department will be headed by J. L. Rosenmiller, who graduated from Lehigh University in 1920 and later developed and became president of the York Oil and Chemical Co. This company merged with the York Ice Machinery Corp. in 1927 and Mr. Rosenmiller became manager of the accessory equipment and supplies division.

The company's advertising department was removed from New York City and combined with the sales promotion department of the company at York in order to give a closer tie-in with the sales executive department. The activities of the new advertising and sales promotion department will be supervised by Anker Winther, assistant general sales manager. Frank Chalmers, who formerly handled advertising exclusively, has been transferred to York and will act as a specialist in advertising and sales promotion activities.

MANUFACTURERS' NEWS

Synthetic Rubber Plant

HYDROCARBON Chemical & Rubber Co., Akron, Ohio, jointly-owned enterprise of The B. F. Goodrich Company and the Phillips Petroleum Company, has changed its name to Hycar Chemical Co., according to announcement by R. W. Thomas, president.

This firm now manufacturing synthetic rubbers in Akron has in addition been recently designated by the Defense Plant Corp. to build and operate another synthetic rubber plant at Louisville, Ky.

The plant in Louisville will be erected at a cost of $2,750,000 under a lease arrangement with the government agency and will have a capacity of 10,000 long tons yearly. A current expansion program at the Akron plant of Hycar will increase production there to 7000 tons annually by early next year.

Littlefuse, Inc., of Chicago has opened a new plant at El Monte, Calif., to supply the aircraft factories located near Los Angeles. The new plant will have some 200 employes, 21,000 sq. ft. of floor space and a 2-acre park with athletic facilities.

Contract for the mechanical refrigerating equipment to be used in air conditioning the large, windowless Douglas Bomber assembly plant, being built near Tulsa, Okla., was recently awarded to the York Ice Machinery Corporation. The cooling capacity is equal to 7000 t. of refrigeration, making it one of the world's largest single installations of refrigerating equipment for air conditioning. Seven steam turbine driven turbo-compressors for water chilling will be used. The aircraft plant is 320 by 4000 ft.

REPUBLIC METERS ARE Bloodhounds

FOR TRACKING DOWN POWER LOSSES THAT HAMPER PRODUCTION

★

TO meet your increased steam demand, you are stretching the capacity of your boilers through shrewd operation. Great! But how much are you gaining if the rest of your plant wastes the steam? Instruments are the bloodhounds that track down these losses.

If you are faced with a steam shortage, a simple Republic metering system will provide data that will enable you to immediately locate and correct faulty or wasteful operating conditions. Elimination of these losses will at once increase your effective power plant capacity.

The engineering of such a system is a definite part of Republic service, rendered by engineers with wide experience in solving industrial metering problems. This engineering service—featuring the highly developed line of Republic flow meters—accounts for the outstanding success of Republic metering systems in hundreds of industrial plants.

This service is made available to you by merely asking to have a Republic engineer call at your plant. Your request will involve no obligation on your part.

REPUBLIC FLOW METERS CO.

2224 Diversey Parkway, Chicago, Illinois

Now Available!

REM-OX

(ANHYDROUS SODIUM SULFITE)

FOR THE REMOVAL OF OXYGEN FROM BOILER FEED WATER

WE ANNOUNCE the immediate availability of REM-OX, a technical anhydrous sodium sulfite, containing 87% available Na_2SO_3, at prices that compare favorably with the commercial product.

REM-OX is packed in 100-lb. multiple bags and 400-lb. wooden barrels for shipment in any reasonable quantity. For further information and prices consult the Philadelphia Main Office, or your nearest Betz representative.

W. H. & L. D. BETZ

General Offices: GILLINGHAM and WORTH STS. (FRANKFORD)

PHILADELPHIA • PENNSYLVANIA

REPRESENTED IN ALL INDUSTRIAL AREAS OF U. S. A. AND CANADA

Flexibility

at both ends of

Community Steam Heat Mains

Saves Trouble and Expense of Expansion Joints

PENFLEX 4-Wall interlocking joint steam hose has greatly simplified the supplying of heat from central plants. The larger illustration shows how your savings start right at the main reducing valve; the upright picture shows how street mains are connected to the line from boiler house.

With ⅝" of "come and go" for every foot of length, in sizes from ½" on up, it is perfectly safe to bury PENFLEX in the ground if so desired. Lengths shorter than those shown are entirely satisfactory where space is limited.

Send for Bul. 52

Longacre Park Heating Co., of Yeadon, Pa., favors

PENFLEX

Pennsylvania Flexible Metallic Tubing Co.

7207 Powers Lane, Philadelphia, Pa.

Roller-Smith Co., Bethlehem, Pa., announces the appointment of the Electrical Jobber Equipment Co., 501 Fourth Avenue, South, Minneapolis, Minnesota, as its sales agent for Minnesota, North Dakota, South Dakota, and that part of Wisconsin west of a line drawn between La Crosse and Ashland.

All-Vac Steam Control Systems with offices at 500 N. Dearborn St., Chicago, Ill., is the firm name of an agency recently founded to distribute licenses to use the patents under which the All-Vac Steam Control System is used. This system, designed to secure high economy in the use of steam, is a hook-up for two pipe steam heating lines, or closed lines used in processing work where an accurate control of pressure and temperature are desired.

OBITUARIES

Robert V. Good

Robert V. Good

ROBERT V. GOOD, manager of the Philadelphia Works of the General Electric Co. since 1936, died September 17, at his home in Drexel Hill, Pa., following a long illness. He was 50 yr. old.

Mr. Good was born in Germany, attended the Royal Technical School at Stuttgart and was graduated in 1911. Coming to the United States, he obtained employment in Cincinnati, and in 1913 joined the General Electric Co. in the general superintendent's office at Schenectady.

Two years later Mr. Good was assigned to efficiency work in the heavy apparatus lines, and in 1919 was appointed to make analytical studies of G-E manufacturing methods. In 1920 he returned to the office of the general superintendent, for the next 3 yr., then going as assistant to the superintendent to the General Electric induction motor department. On January 1, 1928, he became superintendent of the milling department, one of the largest divisions of the G-E Schenectady works.

In May of 1929 Mr. Good was transferred to the Philadelphia Works as assistant manager, and appointed manager, Feb. 1, 1936.

William Le Roy Emmet

W. L. Emmet

WILLIAM Le Roy Emmet, consulting engineer of the General Electric Co. who was known for his contributions in the fields of power generation and ship propulsion, died recently at Erie, Pa., at the home of his nephew, H. L. R. Emmet, manager of G-E's Works there. Mr. Emmet had been ailing from a heart condition. He was 82.

Born at Pelham, N. Y., July 10, 1859, Mr. Emmet was educated at schools in

IRON FIREMAN CUTS COSTS $1885 YEARLY for Denver Laundry Plant

BEN K. LANTZ

Fuel Costs Reduced 29% and one man's time saved . . . these are the accomplishments of an Iron Fireman Pneumatic Spreader stoker in the Lantz Sanitary Laundry Co., Denver. The saving is $1885 yearly.

Reports Ben K. Lantz, president: "While your Pneumatic Spreader stoker replaced another stoker of the over-fire feeding type, which we considered fairly efficient, our new installation is more than meeting our expectations."

Uniform Pressure for Engine

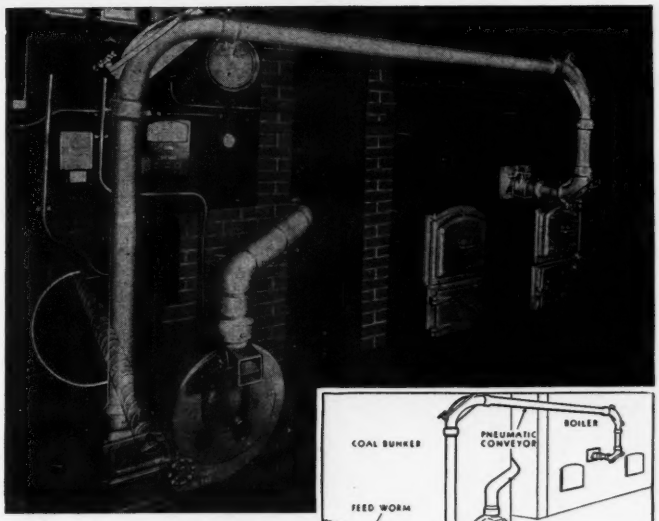
The Lantz Iron Fireman Pneumatic Spreader stoker maintains steady steam pressure, improves production in the whole laundry. Machinery operates more smoothly, efficiently.

Clean Stack

Added to the other benefits is a clean stack. The Iron Fireman Pneumatic Spreader stoker burns coal more completely, minimizes smoke, cuts down ash and coal handling.

Burning Lignite

This Iron Fireman performance record was made with a lignite costing 50 cents a ton less than the coal formerly used. The Pneumatic Spreader stoker feeds lignite from a bunker at one side of the boiler to the firebox, leaving the front of the boiler free for easy access.



Only the Pneumatic Spreader Type of Stoker Can Give You This Flexibility of Installation!

Notice the course followed by the coal—with four 90° turns—in being conveyed from the bunker at left to the boiler front at right; in the boiler room of the Lantz Sanitary Laundry Co. (note bin-feed mechanism shown in phantom above, and in diagram at right).

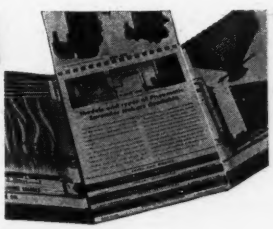
Ask for Survey NOW

The Iron Fireman stoker is *designed*, *built* and *installed* under the constant supervision of the foremost stoker engineering organization in the world. Iron Fireman gives results no other firing equipment can match.

Iron Fireman may be able to help you cut your steam costs. You may consider your present firing equipment efficient, but a free Engineering Survey may show you how Iron Fireman can do a better job, and pay off the investment in fuel savings and improved performance. Ask for this complete survey now. We invite the collaboration of your plant or consulting engineer. You place yourself under no obligation. Send the coupon below.

IRON FIREMAN

Automatic Coal Stokers



SEND FOR FREE NEW PORTFOLIO

Mail coupon, without obligation, for free copy of new Iron Fireman Pneumatic Spreader portfolio. Simple diagrams of stokers, blueprints and operating data of typical installations.
IRON FIREMAN MFG. CO. (Portland, Ore., Cleveland, Toronto.)
Mail to 3025 West 106th St., Cleveland, Ohio.

☐ Send, Free, new Pneumatic Spreader Portfolio.
☐ See us about making, without obligation, an Iron Fireman Engineering Survey.

*Name*_____

*Address*_____

SAVE CHROMIUM

HELP NATIONAL DEFENSE

You can save chromium for defense and save money in your own plant by using our Chrom Glucosate. You are wasting chromium, badly needed in our National Defense program, when you use it for corrosion control instead of chrom glucosate.

Look at this table of comparison. It tells a commanding story.

COMPARATIVE CHROMIUM CONSUMPTION USING GLUCOSATES AS COMPARED TO CHROMATES

Amt. in form of Glucosate	Amt. as dichromate	Application	Saving
SODIUM BICHROMATE			
17 pounds	100 pounds	Calcium Brine	83 lbs.
17 pounds	200 pounds	Salt Brine	183 lbs.
34 pounds	500 pounds	Cooling Water	466 lbs.
CHROMIC ACID			
3 pounds	66 pounds	Calcium Brine	63 lbs.
3 pounds	132 pounds	Salt Brine	129 lbs.
10 pounds	330 pounds	Cooling Water	320 lbs.

Furthermore, there are other glucosates that eliminate the need of chromium. Let us send you the whole story.

Help us to stop the waste of chromium ore. Switch to Chrom Glucosate at once and tell your business acquaintances the story of Chrom Glucosate too.

WATER CONSULTANTS

D. W. HAERING & CO., INC.

GENERAL OFFICES: 205 West Wacker Drive

CHICAGO, ILLINOIS

IF YOU S-L-O-W DOWN YOUR PUMP SPEED—

WILL YOU SAVE STEAM?

This NON-TILTABLE Valve *Closes Quickly, Reducing Wear, Prevents Slippage, Makes Steam Do More Work.*

"Yes, indeed," say the scores of engineers who have installed COMBINATION Pump Valves. These improved *non-tilting* valves close quickly, enable the pump to handle its theoretical capacity without racing and thus wasting costly steam. Then, too, their extra durable construction (seat, stud and spring are Phosphor Bronze) means fewer pump shutdowns for overhauling, real savings in maintenance.

Watch Them Pay Their Way. After checking over many performance records where COMBINATION Pump Valves have returned their cost in from 3 to 9 months, we are prepared to make this liberal offer to engineers. These valves must pay their way on your particular pump job, or else they will not cost you a single penny. Either they make good, or we will. The coupon brings you full information about this opportunity to prevent steam wastage and too frequent pump repairs. Fill in and mail the coupon NOW.

COMBINATION PUMP VALVE CO.

846 Wiota Street Philadelphia, Pa.

Without obligation, please send me full details about your Trial Offer on COMBINATION Pump Valves.

Name .....

Company .....

Address .....

MAIL COUPON TODAY

Canada, New York, and subsequently entered the United States Naval Academy, where he was graduated in 1881. Mr. Emmet first became associated with electrical work in 1887 when he entered the employ of the Sprague Electric Railway and Motor Co. He later went with the Buffalo Railway Co. as electrical engineer, and soon afterward accepted a position with the Edison General Electric Co., in the Chicago district, coming to Schenectady in 1892 when the Thomson-Houston Co. joined with the Edison General Electric Co. to form the General Electric Co.

As early as 1909 Mr. Emmet pointed out that electric ship propulsion was feasible, economical, and practical, and he did significant work in developing the steam turbine from the embryonic to the practicable stage. He also worked out the Emmet mercury vapor process of power generation.

Largely through his efforts, the Navy Department in 1913 was induced to allow an installation of turbine-electric drive in the collier Jupiter, success of this installation leading to adoption of electric drive for a number of large U. S. Navy warships, first of which was the New Mexico. His later work on gears for ship propulsion placed the General Electric Co. in a position to produce geared-turbine propulsion equipment for 40 destroyers and 300 merchant ships during the war period from 1915 to 1922.

Prior to his achievements in the steam turbine field, Mr. Emmet encouraged the use of alternating current, and a number of inventions making possible its practical use stand to his credit. He made significant contributions in the field of electrical insulations, inventing varnished cambric cable; also invented several types of transformers.

He received the honorary degree of D.Sc. from Union College in 1910, and later the same degree was conferred upon him by Trinity College. He was awarded the Gold Medal at the St. Louis Exposition for his work in developing the vertical shaft turbine, the Gold Medal for electric ship propulsion at the San Francisco Exposition, and the Elliott-Cresson Medal in 1920.

C. L. Clarke

CHARLES LORENZO CLARKE, oldest of the Edison pioneers and last of seventy-one charter members of the American Institute of Electrical Engineers, succumbed to pneumonia on October 9th at his home in Newton, Mass. He was eighty-eight years old.

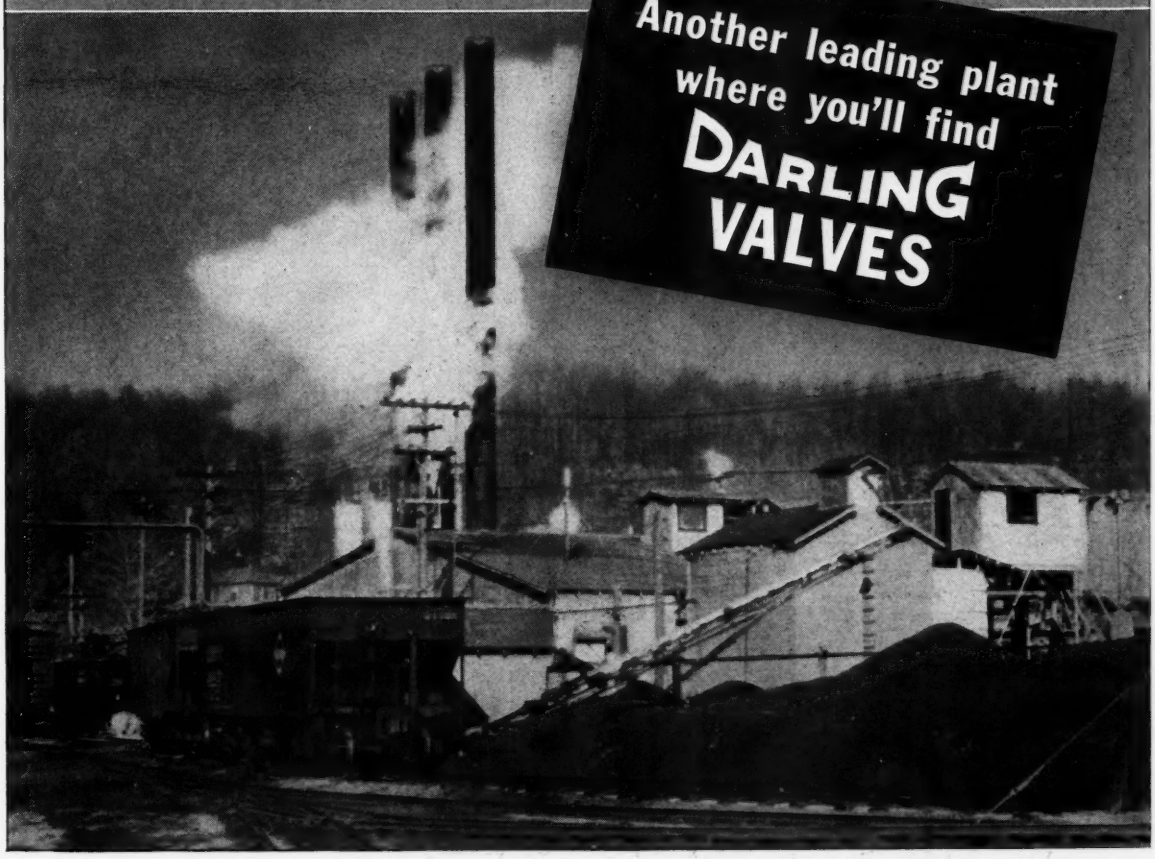
Mr. Clarke worked with Thomas A. Edison from 1880 to 1884, first as research assistant and later as the great inventor's chief engineer. He supervised the mechanical engineering involved in the construction and operation of the Edison Company's central station at 257 Pearl Street, New York City, the world's first generating plant for incandescent lamp current. During this period he also designed the famous Jumbo dynamos and many electric generators.

Mr. Clarke was born in Portland, Me., on April 16, 1853. Graduating from high school he worked for the Boston & Maine Railroad, later studied at Bowdoin College, still later joined Edison and his workers at Menlo Park, N. J.

Leaving the Edison Co. in 1884, Mr. Clarke became engineer for the Telemeter Co., New York, and later for the Gibson Electric Co., a concern interested in the development of storage batteries.

The ATLAS POWDER COMPANY Plant

at White Haven, Pa.



Manufacturing explosives calls for the last word in dependable equipment. And Atlas Powder Co., one of the nation's leaders in explosives production, is another user of Darling Gate Valves.

Top-flight performance comes naturally to Darling Valves. That's the way they're built. Materials are selected with *extra* care. Craftsmanship is painstaking. And every valve is tested *individually* (not just one out of a group of valves—Darling values its reputation too highly to take chances with a short-cut).

Result: Darling Valves meet the requirements of every application. You get year after year of trouble-free, economical operation.

You'll find it pays to specify Darlings.

DARLING VALVE AND MANUFACTURING CO.

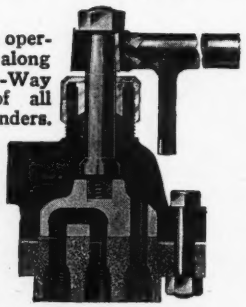
Williamsport, Pa.

REPRESENTATIVES IN:

NEW YORK PHILADELPHIA HOUSTON TOLEDO PITTSBURGH
CHICAGO ST. LOUIS HUNTINGTON, W. VA. McPHERSON, KAN.

"...They Stay Tight as a Drum"

THAT'S the good word operating engineers pass along about Nicholson 2, 3, 4-Way Valves for operation of all steam, air or water cylinders.



Non-corrosive metals are used on all vital Nicholson Valve parts. And regrinding is a simple operation that can be done several times before replacement is necessary. As a rule, these improved control valves remain absolutely tight for six to eight years or longer without repairs of any kind.

Nicholson also offers foot, solenoid and motor operated valves; and valves for hydraulic service up to 5000 lb. pressure. Catalog No. 140 brings you the complete data on these tight, money-saving controls.

Other Products—Steam Traps, Air Traps, Floats, Steam and Air Separators, etc.

W. H. Nicholson & Co., 160 Oregon St., Wilkes-Barre, Pa.

Specify NICHOLSON Three and Four-Way CONTROL VALVES

GET MORE POWER QUICKLY with ENCO Streamlined BAFFLES

THE advantages of Enco Patented Streamlined Cross Flow Baffles have been so definitely established that all water tube boilers, whether new or old, should be equipped with them as a first step to better steam plant efficiency.

Every Enco Baffle Wall is designed to obtain the best results from the heating surface available in each boiler. Constructed of specially developed materials and installed gas tight by skilled mechanics.

Streamlined to avoid eddy currents and eliminate dead gas pockets that collect soot and fly ash. They save live steam because soot blowers work less often and more effectively.

Write for Bulletin B-40. It tells why Enco Baffle Walls improve the performance of new and old boilers to deliver more steam at lower cost.

THE ENGINEER COMPANY
75 WEST STREET (Enco) NEW YORK, N.Y.

In 1889 Mr. Clarke became a consulting engineer, specializing in patent work. He served as engineer for the board of patent control of the General Electric Company and Westinghouse from 1901 to 1911, when he was appointed consulting engineer for General Electric, with whom he remained until his retirement 10 yr. ago.

Mr. Clarke was a member of the American Society of Mechanical Engineers, the New York Electrical Society, and an honorary fellow of the American Electro-therapeutic Association. He held Bachelor of Science, Master of Science, and Civil Engineering degrees.

NEWS FROM THE FIELD

New Officers for A. S. M. E.

OFFICIAL announcement of the recent election by letter ballot of the American Society of Mechanical Engineers was made by C. E. Davies, secretary of the Society on October 1.

James W. Parker, vice-president and chief engineer of the Detroit Edison Co., was elected to be president of the Society during 1942.

Vice-presidents elected at the same time to serve two-year terms on the Council of the A.S.M.E. were Clarke F. Freeman, senior vice-president and engineer of the Manufacturers Mutual Fire Insurance Co. and its associated companies, Providence, R. I.; C. B. Peck, managing editor of Railway Mechanical Engineer, New York, N. Y.; W. H. Winterrowd, vice-president of The Baldwin Locomotive Works, Eddystone, Pa.; and W. R. Woolrich, dean of the College of Engineering, and director of the Bureau of Engineering Research of the University of Texas, Austin, Texas.

Managers of the Society elected to serve on Council for three-year terms include W. G. Christy, smoke-abatement engineer of Hudson County, New Jersey; H. L. Eggleston, manager of the gas and refining departments, Gilmore Oil Co., Los Angeles, Calif.; and T. S. McEwan, who was last year selected to head the defense contract service of the Office of Production Management in Chicago as district manager.

The new officers will be installed during the 62nd Annual Meeting of the Society in New York, N. Y., at the Hotel Astor, December 1-5, 1941.

A. S. R. E. Local Meetings

PLANS are in making for fall and winter meetings and are well advanced. All are open to guests and non-members and so that engineers interested in refrigeration and air conditioning may be able to avail themselves of meetings when traveling, the schedule as prepared are given.

Baltimore-Washington section meets in Engineers' Club, Baltimore, the 4th Thursday of the month or on Nov. 20, Jan. 22, Feb. 26, Mar. 19, Apr. 23.

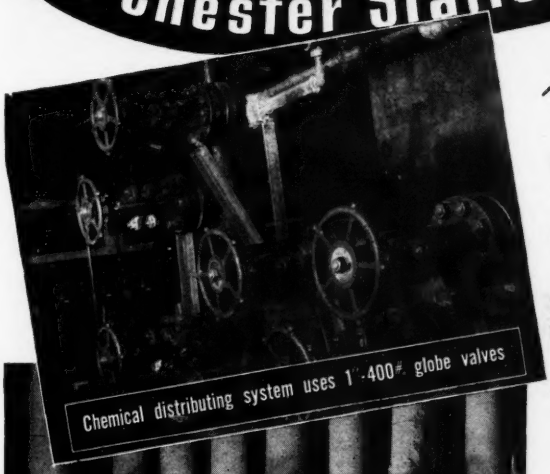
Boston section meets the 3rd Friday, on Oct. 17, Nov. 21.

Chicago section met at Drake Hotel Oct. 16 to consider Air Distribution in Refrigerated Spaces. Other meetings will be Nov. 20, Jan. 15, Feb. 12, Mar. 12, Apr. 16, May 14.

STEAM VALVES

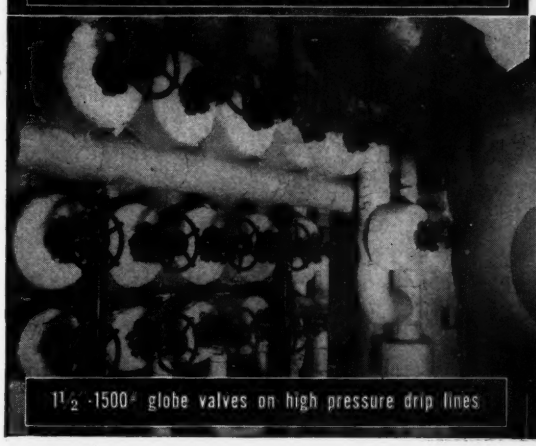
on Chester Station's New No.5 Unit!

by Vogt



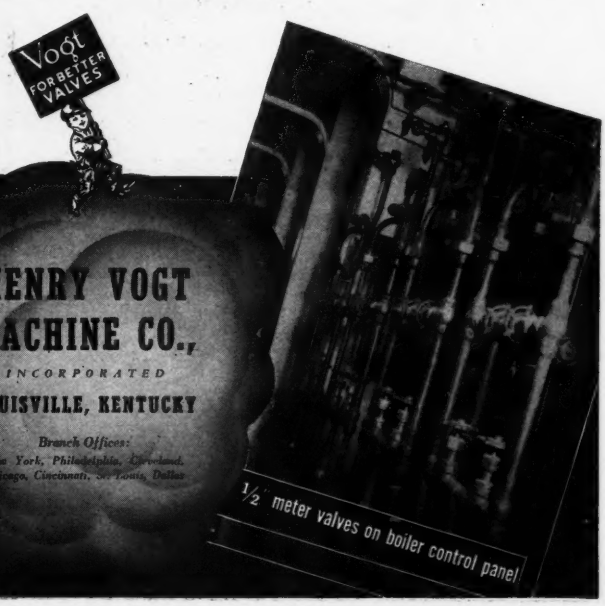
Chemical distributing system uses 1"-400# globe valves

1¼"-600# gate valves on desuperheater manifold



1½"-1500# globe valves on high pressure drip lines

Vogt Steel Valves are d-r-o-p f-o-r-g-e-d and that's why they are extra strong and extra tough . . . operating with a maximum of dependability and a minimum of maintenance in exacting flow control services . . . the kind of performance that is a "must" with power plants like Chester Station of the Philadelphia Electric Company.



½" meter valves on boiler control panel

HENRY VOGT MACHINE CO.,
INCORPORATED
LOUISVILLE, KENTUCKY
Branch Offices:
New York, Philadelphia, Cleveland, Chicago, Cincinnati, St. Louis, Dallas

This Watchdog Puts STEAM-WASTERS on the Spot

Always on the job, always accurate, Simplex Venturi Type Meters keep you constantly posted on the steam requirements of all plant equipment. They serve as a money-saving combined watch-dog and bookkeeper.

Compact in design and built for wide range service, these Simplex Meters are widely used for Boiler Feed, Steam Condensate or Evaporate flow measurement.

SIMPLEX TYPE MS METER

Furnished in any size and for operating pressures up to 2500 lb.
Write for Bulletin No. 52.

SIMPLEX VALVE & METER CO., 6790 Upland St., Philadelphia, Pa.

SIMPLEX METERS

What Advertising Really Is

"What advertising is, in simple terms, is a time-saver. It does little or nothing that cannot be done by other means, if you don't care how long it takes and are more interested in delegating matters to posterity than you are in feeding the current generation. It saves time in introducing betterments and innovations, in communicating benefits and values — in finding, holding and expanding markets. Like most time-savers, it is a money-and-muscle saver as well."

ARTHUR KUDNER,* President
Arthur Kudner, Inc.

**From a talk delivered at Presentation Dinner of the Annual Advertising Awards*

Cincinnati section met in Hotel Gibson Oct. 20 with papers on Dehumidification by Adsorption, and on Heat Exchangers to Improve Evaporator and Compressor Performance. Other meetings will be Nov. 17, Dec. 15, Jan. 16, Feb. 16, Mar. 16, Apr. 20, May 18.

Cleveland section will meet Nov. 28, Jan. 27, Feb. 24, Mar. 24.

Detroit section will meet Nov. 3, Jan. 5, Feb. 2, Mar. 2.

Kansas City section met in Hotel Phillips Oct. 23 for a paper on Tube Ice Machines. Other meetings on Nov. 20, Jan. 22, Feb. 26, Mar. 19.

Los Angeles section will hold meetings on Nov. 11, Jan. 13, Feb. 10, Mar. 10.

Milwaukee section will meet Nov. 26.

New York City section met Oct. 3 at Building Trades Club to discuss The Defense Program and Relations with OPM. Later meetings will be Nov. 7, Feb. 6, Mar. 6, Apr. 3.

Philadelphia section meetings will be Nov. 14, Dec. 12, Jan. 9, Feb. 13, Mar. 13, Apr. 10, May 8.

Pittsburgh section will meet Nov. 7, Jan. 2, Feb. 6, Mar. 6, Apr. 3.

Richmond section will meet on Nov. 11, Dec. 9, Feb. 10, Mar. 10, Apr. 14.

St. Louis section will meet in Jefferson Hotel Nov. 14, Jan. 9, Feb. 13, Mar. 13.

STATEMENT of the ownership, management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of POWER PLANT ENGINEERING, published monthly at Chicago, Illinois, for October 1, 1941.
State of Illinois, } ss.
County of Cook, }

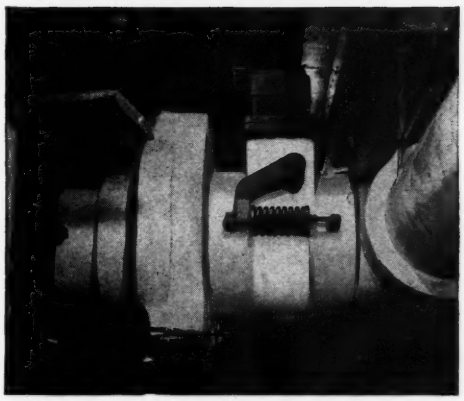
Before me, a Notary Public in and for the State and county aforesaid, personally appeared K. L. Rice, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Power Plant Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Technical Publishing Company, Chicago, Ill.
Editor, R. E. Turner, Chicago, Ill.
Managing Editor, None
Business Manager, K. L. Rice, Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Protect
Low Pressure Apparatus from Excessive Pressures *with the* . . . . . KENNEDY-ERWOOD *Safety* Swing Gate Valve



Typical installation of the Kennedy-Erwood Swing Gate Valve on the exhaust line between turbine and condenser. An extended stem with floor stand in the turbine room permits convenient hand-operation, and the spring may be set for automatic relief at any predetermined pressure.

This unique design combines the functions of a gate valve, check valve, and relief valve in a single unit. It may be hand-operated as a standard gate valve, and when closed, its adjustable spring-controlled disc will automatically relieve excessive unbalanced pressure in any apparatus or pipe line.

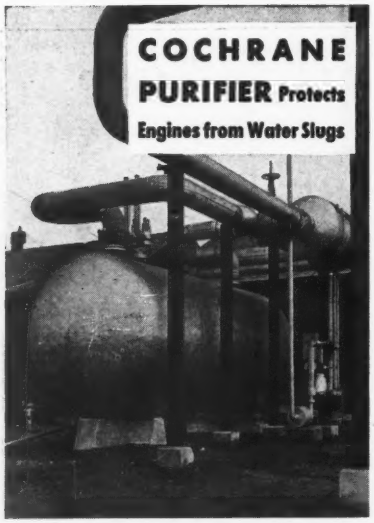
For example, used as a non-return valve on the exhaust line between turbines or engines and condensers or heaters, the Kennedy-Erwood valve protects the low-pressure casing against building up of pressure which might cause failure and serious damage to equipment or injury to operatives.

Other applications are as a back-pressure valve, atmospheric relief valve, or safety gate valve on pumps, compressors, etc.

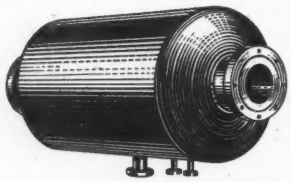
Write for full information on this important aid to greater plant safety.

THE KENNEDY VALVE MFG. CO.
ELMIRA, N. Y.

KENNEDY-ERWOOD *Safety* SWING GATE VALVES



AT Glen Alden Collieries, near Scranton, Pa., steam is required for two shaft-hoisting engines at periodic intervals lasting about 36 seconds each. During acceleration the demand is about 75,000 lb. per hour but if both engines happen to be hoisting at the same time the load may be 150,000 lb. per hour. The installation of a Cochrane Purifier in the steam line supplying the engines, insures a clean, flexible steam supply. The slugs are drained from the Purifier by a Cochrane Drainer and flashed to atmosphere.



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4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is .....
(This information is required from daily publications only.)

K. L. RICE,
Business Manager.

Sworn to and subscribed before me this 26th day of September, 1941.
JOHN O. AARVOLD.
(My commission expires March 20, 1944.)

J. M. McClintock, Chicago, Manager, Free-Man Stoker Division, Illinois Iron & Bolt Co., was appointed interim President of the Stoker Manufacturers Association at a recent meeting of the Executive Committee held in Chicago. Mr. McClintock succeeds Frank Hoke of Indianapolis, who resigned to become Indiana State Director of contract distribution service for the Office of Production Management, with headquarters in Indianapolis. B. O. Fink, Auburn, Indiana, President, Auburn Foundry, continues as Vice President of the Association. R. W. Conkey, Mendota, Illinois, was appointed Treasurer of the Association to succeed Mr. McClintock, who has been serving in that capacity since the first of the year, also was appointed to the Executive Committee. E. C. Sammons, Portland, Oregon, Vice President, Iron Fireman Manufacturing Co., takes the place of Mr. Hoke as Chairman of the stoker industry's National Defense Committee.

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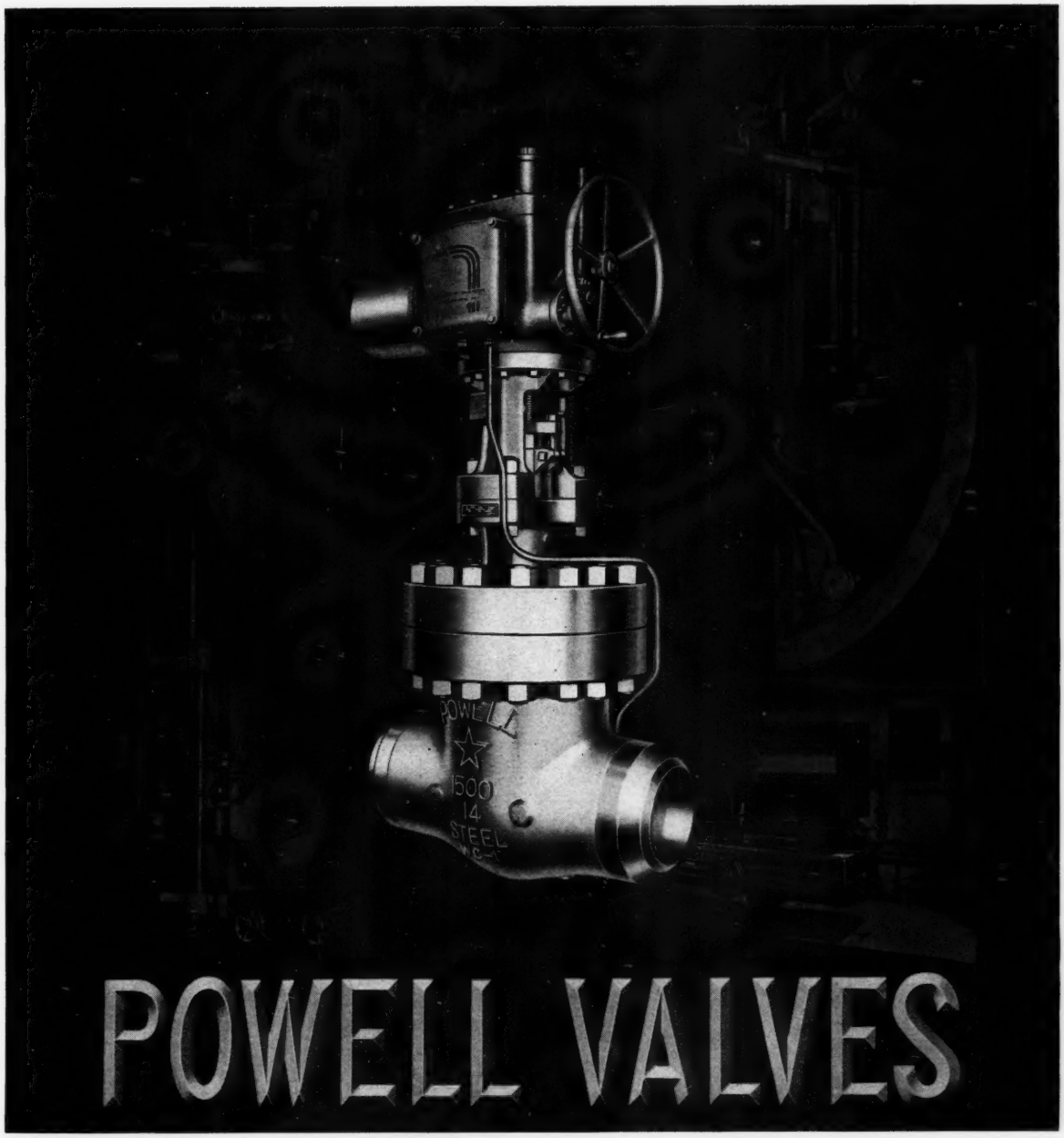

POWELL VALVES

BEHIND *the* SCENES

The fact that Powell Valves are exceptional in their performance of the jobs for which they were designed is no accident. Before a pattern is made, before a casting is poured, before a wheel is turned, the Powell Research Engineering Staff will have completed its painstaking examination of every phase of the job to be done and will have approved the fitness of the material and the design of every part to be used.

Such thoroughness requires not only men of experience and skill, but a vast array of highly specialized technical equipment in constant service.

The valve shown here is a 14" class, 1500 lb. cast Steel Gate Valve for operation on 920°F. steam at approximately 1500 lb. working pressure. It is equipped with Limitorque, top-mounted, spring compensated motor operator. Its record in use is ample justification of the work done behind the scenes before it was introduced to American industry—indeed, before it was built.

The Wm. Powell Company
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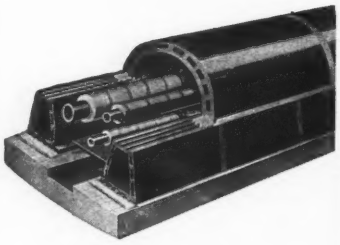

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Non-yielding monolithic concrete base. No broken stone fill. No bell joints. Build to correct grade with Therm-O-Tile and that grade will never change. Condensate pockets cannot form. Strong arched construction. Internal channel drain, etc. For the numerous other reasons why Therm-O-Tile is by far the superior conduit system, ask for Bulletin 381.

Therm-O-Tile is sold and installed by Johns-Manville Construction Units in all Principal Cities.

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Without obligating us in any way, ☐ Please send Bulletin 381. ☐ Send a representative. ☐ Enclosed is a sketch, with principal data of a prospective job, on which we shall be glad to have your ☐ comments, ☐ quotations.

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Chemical Exposition

NEW achievements in America's march toward economic independence will highlight the 18th Exposition of Chemical Industries, coming to Grand Central Palace, New York, December 1-6. Problems of national defense will be the keynote, but underlying this theme will be a very large amount of evidence pointing out the nation's strategic advance toward self-sufficiency.

Information on exhibitors' plans, gathered by the International Exposition Company, of which Charles F. Roth is president, reflects the important task which industrial and engineering chemistry has assumed in this war. Chemical process industries, which got their start in the last world war, have become one of the principal ingredients in the new defense program. The Exposition will emphasize their progress.

Significant facts which many of the exhibits will reflect bear out the following points: Partly chemical industries are becoming more chemical. Non-chemical industries are consuming more chemical products and adopting chemical methods. Artificial materials are rapidly replacing natural products.

New taxes were imposed on goods and supplies recently pertaining to the power industry as follows:

Ten per cent on Electrical Appliances, Gas and Oil Appliances, Electric Signs, Business and Store Machines, Washing Machines (Commercial), Rubber Articles. Five per cent on Electric Light Bulbs.

Taxes were increased as follows: Automobile Tires from 2½ cents to 5 cents a pound; Inner Tubes from 4½ cents to 9 cents a pound; Passenger Automobiles from 3½ per cent to 7 per cent; Auto Trucks, parts and accessories, from 2½ per cent to 5 per cent; Refrigerators, Air Conditioning Equipment and Radio Sets from 5½ per cent to 10 per cent; Telegraph messages from 5 per cent to 10 per cent.

Starting Feb. 1, 1942, a use tax of $5 a year will be collected on all motor vehicles.

SAUERMAN

Power Scrapers

★ **The problem of storing coal safely and economically has been solved permanently at hundreds of steam generating plants, both large and small, by installing Sauerman Power Scrapers.**

A Sauerman scraper unit has no equal for simplicity of installation and operation, nor does any other method of storing and reclaiming carry as positive an assurance of building a coal-pile that will be free from the chance of spontaneous combustion.

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WANTED—Turbine and Switchboard Operator for Industrial Plant located in the South. Must be experienced in operation of General Electric extraction type turbines, switchboard and auxiliary equipment. In replying give full details. Address—Box No. 1219, c/o POWER PLANT ENGINEERING, 53 West Jackson Blvd., Chicago, Ill.

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If you read the advertisements of such concerns, which are found regularly in POWER PLANT ENGINEERING, and study their messages, you can be confident of buying trustworthy power plant machinery and equipment from these progressive advertisers.

IT IS IMPORTANT, TODAY, THAT THESE VALVES HAVE BEEN BUILT TO "TAKE IT"

As an example of what we mean: READING-PRATT & CADY Cast Steel Valves employ wall thicknesses that exceed all other established standards. They withstand corrosion and erosion longer.

Further—and equally important—the renewable features of these valves enable you to continue them in service with the minimum usage of metals that have become scarce and strategically essential.

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READING-PRATT & CADY Cast Steel Gate Valve Figure 3001. Cast Carbon Steel, Stainless Steel trim 300 lbs. steam at 750°F.... Alloy steel with rating of 300 lbs. at 900°F. Flanged, screwed and welding ends.

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Philadelphia Rate Reduction

H. P. LIVERSIDGE, president, announced effective Sept. 1 the largest single electric rate reduction in the history of the Philadelphia Electric Co. This will amount to $4,000,000 annually and was recently ordered by the Pennsylvania Public Utility Commission. In making formal announcement of the reduction, Mr. Liversidge pointed to the fact that electric rates have been definitely lowered in every year, with a single exception, since 1928. These reductions, including the one effective Sept. 1, represent total annual savings to customers of more than $20,000,000.

All classes of electric customers are benefited by the new schedules: residence customers saving in excess of $1,250,000; smaller commercial and industrial users about $1,970,000; and, larger commercial and industrial customers slightly more than $635,000 annually. Savings will also accrue to the city and federal governments and to various municipalities in the company's service area.

As of May, 1941, the company had 415,613 residence customers in the city of Philadelphia and 177,673 in its suburban area. The total number of customers served in all classifications is in excess of 742,000.

Organization of the Indiana Municipal Electric Assn. was started at Tipton, and perfected at a meeting in Frankfort on Oct. 29. Organization committee was Abe Martin of Frankfort, Jesse Tudor of Tipton, Ernie Wells of Pendelton. Temporary officers were Abe Martin, chairman, Jim Caldwell of Rushville, secretary-treasurer, Louis Ramp of Rensselaer, membership chairman, Worth Yoder of Tipton, organization chairman. Priorities, standardization of equipment, credits and emergency exchange of materials were topics discussed.

On October 16 the Carborundum Co. dedicated an educational exhibit, telling the story of modern manufactured abrasives which has been installed at the Chicago Museum of Science and Industry. One of the striking features of the exhibit is the reproduction of the laboratory of the late Dr. Edward Goodrich Acheson in which he created the first man-made abrasive silicon carbide to which he gave the name Carborundum. A revolving mound of colored crystals of Carborundum Brand Silicon Carbide is displayed on a circular base of black marble. Detailed processes are shown in a series of diagrams, and in a demonstration booth are shown grinding processes.

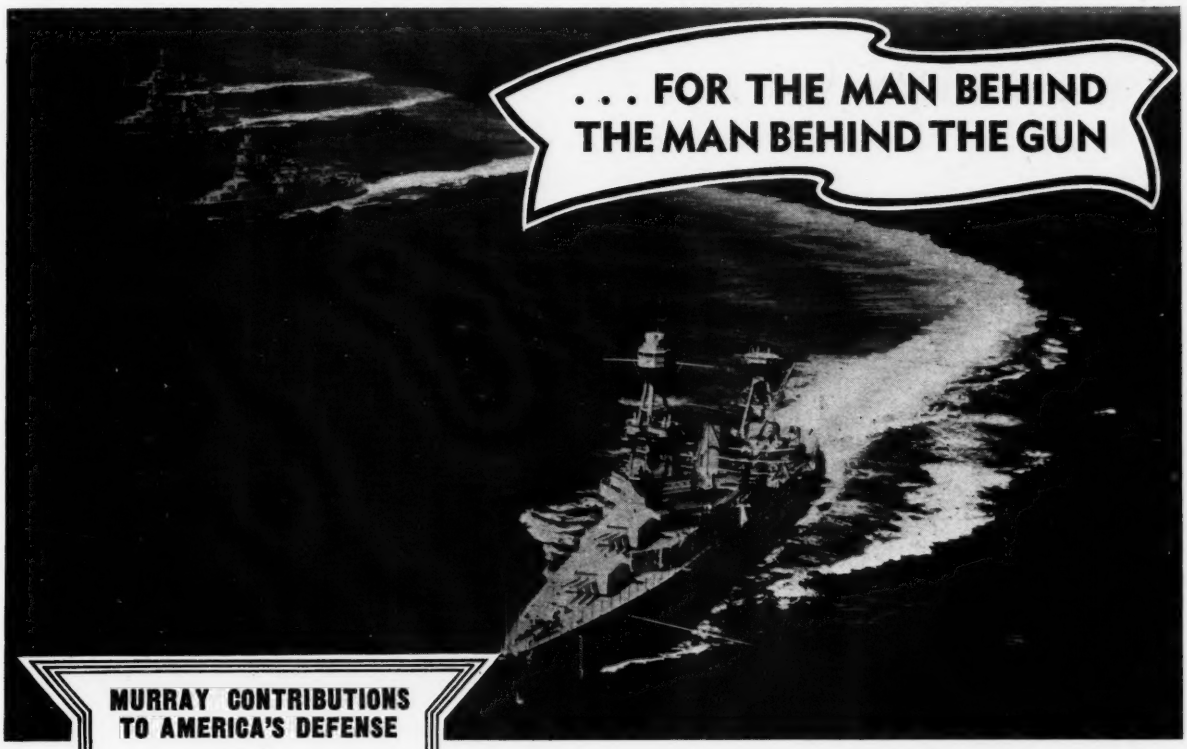
Pittsburgh, Pa., smoke ordinance went into effect Oct. 1, providing that industrial plants may emit only a very light gray smoke and that new installations of heating equipment must have devices to burn fuel smokelessly or must burn smokeless fuel. A 12-man Bureau of Smoke Prevention, headed by Sumner B. Ely of Carnegie Institute is in charge of enforcement.

At the recent Atlanta meeting of Illuminating Engineering Soc., Arthur A. Brainerd and Matt Denning gave results of their 2-yr. investigation into Improved Vision in Machine Tool Operation by Color Contrast. In tests of light colors under incandescent and mercury lighting, light buff and light gray showed highest scores in psychological effect accident hazard reduction and increasing production. Aluminum showed high and light blue promising.

As a practical compromise, painting machines horizon gray and spotlighting the working area with light buff seemed to show better results than solid colors. Further tests are under way by Mr. Denning who is director of trade sales of Finishes Division of the Du Pont Co.

Re-employment of men returning to civilian activities from selective service and from completion of terms of service in the regular army, navy or marine corps is urged as a patriotic duty of employers by Brigadier General Lewis B. Hershey, Director of Selective Service. Men discharged will be given forms to fill out which will indicate civilian experience and qualifications, with warning not to overrate their abilities, but to give accurate, clear and concise statements. While re-establishment of returning selectees is primarily the job of local service boards, cooperation will be given by State and United States employment offices. Each man should get in touch with his local board re-employment committeeman, and employers should extend a helping hand by listing with local committees jobs available in their plants.

MORE POWER



MURRAY CONTRIBUTIONS TO AMERICA'S DEFENSE

Boilers
★
Turbo-Generators
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Mechanical Drive Turbines
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Unit Heaters
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Gears

Business with Murray is not "as usual." Much of our engineering skill and production facilities now are being centered on designing and building power equipment for America's vital defense industries.

Among Murray's outstanding contributions to national defense are the driving turbines on the compressors for the largest industrial air conditioning installation made in America, a 7000 HP. job for a large builder of airplane engines . . . the turbo-generators for one of the largest Ordnance Plants . . . and large quantities of equipment for Navy, Army and Maritime installations.

Although "defense orders must come first," Murray will continue to cooperate with and meet the power equipment demands of civil industries as far as it is humanly possible.

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

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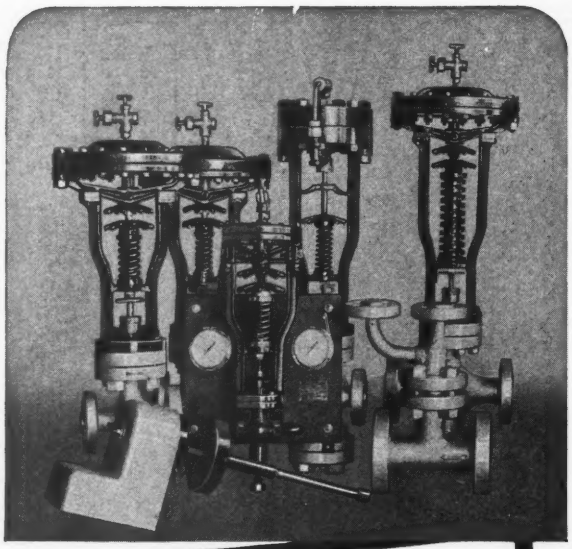

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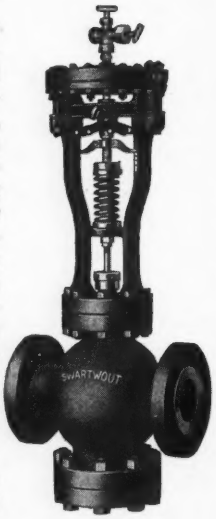
with **Swartwout** *reducing and desuperheating controls*

NO JOB in your plant is bigger than conditioning initial steam for various uses "down the line." Swartwout Equipment takes an enormous load off your shoulders—rigidly controls temperature and pressure • Protection of costly machinery, assurance against time loss, provision for instant shut-down when the safety of lives or equipment is endangered—that's the "big order" involved in the *SIX complete Swartwout reducing and desuperheating stations* recently installed by one of the largest public utilities. (One set of equipment shown in photograph.) They reduce steam from 1450 lbs., 950° F., to 450 lbs., saturated; continuous service, widely fluctuating load — a completely "worryless" control. *Write for data.*



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•Power Plant Equipment•
Also Industrial & Commercial Roof Ventilators

Conservation of Nickel

As a National Defense measure, recent work of committees of the A.S.T.M., in collaboration with the Office of Production Management, has resulted in the following recommendations for the use of nickel:

1. In general, nickel should be limited to heat-resisting alloys to 15 per cent, in the case of castings subjected to oxidizing conditions and controlled atmospheres at elevated temperatures.

2. Where oxidizing conditions exist and castings are not required to carry high loads, straight chromium irons containing not over 2 per cent nickel should be used in preference to alloys of the 25 per cent chromium, 12 per cent nickel type.

3. That a limit of 40 per cent nickel is adequate in heat-resisting alloys for use in carburizing and nitriding, and dry cyaniding atmospheres.

3-a. That in some gas carburizing equipment conditions are so severe as to require alloys having a high nickel content and where the necessity for using such alloys is established nickel should be limited to 62 per cent.

4. Nickel should be limited to 40 per cent for applications involving severe thermal shock.

5. The life of electric resistance heating elements is a matter of the nickel content. The types of alloys required are the 35 nickel, 15 chromium type useful at furnace temperatures up to 1400 deg. F., 60 nickel, 12 chromium type useful at temperatures 1400 to 1650 deg. F. and 80 nickel, 20 chromium for temperatures above 1650 deg. F.

6. Nickel alloys in use as thermocouple material must retain present composition since these are specific to calibration.

Commissioner Basil Manly of the Federal Power Commission advocated in a recent address before railroad and utilities commissioners that for investments in facilities, those whose useful life is limited to the period of the defense program should be amortized during that period; where useful life will continue beyond the emergency period, such life should be estimated and amortization be charged accordingly, but depreciation on all utilities may well be charged at a higher rate during the period of intensive activity, since deterioration will be more rapid, and a lower rate of depreciation allowed after activity has slackened. This method may well be applied to all utility plants, both existing and those built for the defense program, and will serve to make up for any inadequate depreciation in previous reserves, as well as increasing financial stability of companies. Rate reductions would not, however, be justified because of temporary increase in revenues, nor would rate increases because of temporary increase in expenses.

Adjustments will be necessary to meet changing conditions, but the principle advocated by the Commission is that increase in profits due to defense activity should, after deducting increase in expenses due to such activity and amortizing capital expenditures for plant which will be useful only during the emergency, be applied to reducing net investment in the plant, no excess profits being allocated to surplus or to increasing of dividends. Return on emergency capital expenditures is recommended to be allowed as 6 per cent.

Consolidation of the Mechanical Drive and Turbine-generator Sections at General Electric's Lynn River Works has been announced by C. S. Coggeshall, manager of the company's Turbine Division. J. L. Kerr is named manager of sales of the consolidated Lynn section, with L. D. Whitescarver, formerly a turbine specialist in the company's Atlantic District, as general assistant.

All of the company's business in land and marine turbines rated at 7500-kw. and less will be handled through the Lynn section, as well as mechanical drive turbines and generator sets of 400-kw. and less.

Since January, 1938, Mr. Kerr has been manager of sales of turbine-generators manufactured at the G-E Lynn River Works. He has been with the company since 1913 when he entered the testing department, beginning turbine sales work in 1917; for a 10-yr. period beginning in 1928 he was a turbine specialist in the central district. He has been a turbine specialist in the Atlantic District since November 1939.

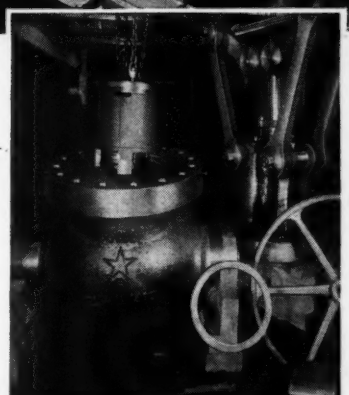
J. R. Casey, of the Turbine Division at Schenectady, has been appointed to Mr. Whitescarver's post in the field. Mr. Casey entered the company's Testing department following his graduation from Worcester Polytechnic Institute in 1937 with the degree of Bachelor of Science in Electrical Engineering.

TWO STEPS AHEAD OF PLANES AND TANKS...

Before planes, tanks, guns and ships come the machines to make them. And to drive the machines Industry needs Power. The capacity to produce that power was not created overnight.

For years the makers and users of power equipment had been quietly searching for ways to boost production of power. New methods were studied . . . different metals were tested. And the years of research bore fruit. From 1920 to 1938 steam pressures were increased four times. New boilers ten times as powerful as 1920 models were built. Today, aided as in peacetime tasks by INCO Nickel Alloys, they are assuring an uninterrupted flow of the driving force essential to all-out production.

The unexcelled performance of Monel*, "S" Monel*, "K" Monel* and the other INCO Nickel Alloys as vital parts of Power Plant equipment has been demonstrated for years. Today, the need for these metals is more pressing than ever.



12-inch toggle-operated non-return valve with welding ends for 1500 lbs. W.S.P. at 900° F., as manufactured by Wm. Powell Co., Cincinnati. The cylindrical guide for disc, and the disc itself shown in foreground are made of cast "S" Monel heat-treated to 320-350 Brinell.

• • •

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

INCO NICKEL ALLOYS

MONEL ★ "K" MONEL ★ "S" MONEL ★ "R" MONEL
"KR" MONEL ★ INCONEL ★ NICKEL ★ "Z" NICKEL

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INCO MONEL

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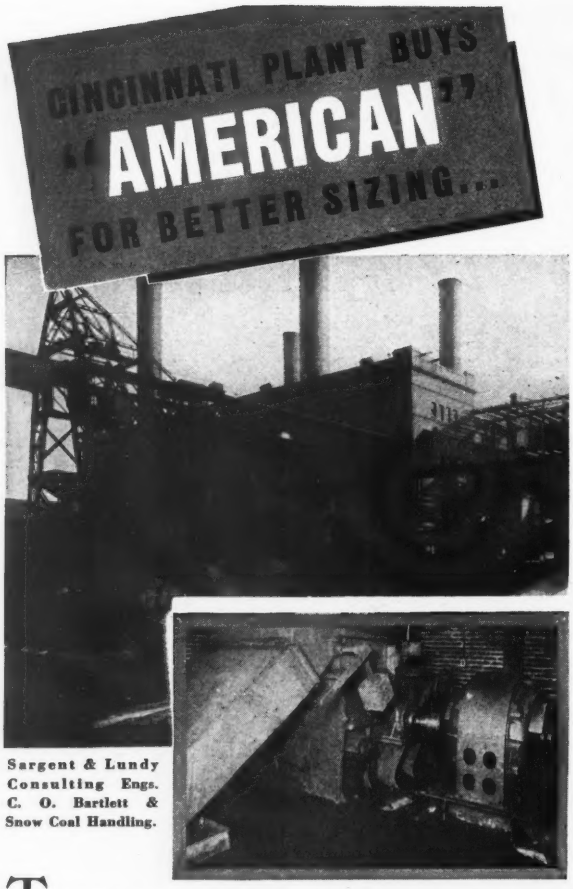

Sargent & Lundy Consulting Engs. C. O. Bartlett & Snow Coal Handling.

THE Union Gas & Electric Company at Cincinnati is one of the growing list of central stations and industrial plants which use AMERICAN Ring Crushers to insure better coal sizing and get cheaper steam.

As pictured above, the Type AC AMERICAN Crusher reduces coal from run of mine to screenings —efficiently sizing it at the rate of 250 tons per hour. This more uniform sizing means a higher and more constant CO_2 and the carbon content of the ash is reduced.

You, too, have an opportunity with AMERICAN Crushers to step up boiler performance and step down operating costs. Used in connection with stokers or pulverizers, the cost of preparation the "AMERICAN" way is surprisingly low. It will pay you to investigate. Ask us to supply engineering and performance data for plants like yours.

AMERICAN PULVERIZER COMPANY
1429 MACKLIND AVE. ST. LOUIS, MO.

AMERICAN Ring CRUSHER

New Engineering Books

Motion Study. By Herbert C. Sampter. Published by the Pitman Publishing Corporation, New York, N. Y. Size 5¼ by 8 in.; 155 pp.; cloth bound. Price $1.75.

The science of Motion Study is brought within the province of supervisors and workers of all levels through this simply written, well illustrated handbook of the basic principles. Use of flow process charts is emphasized to eliminate jobs that should not be studied at all. Work being done is recorded through charts placed in the hands of those doing it; through these same charts workers are awakened to the outsider's point of view. This plan is applied to flow of materials and to those all too frequently overlooked tasks such as janitor work, repair work, etc., as well as to individual work requiring the study of hand motions.

Tool Design. By C. B. Cole. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago. Size 5½ by 8½ in.; cloth bound; 479 pp. Price $4.50.

This is a companion volume to the author's Tool Making, covers the same general field of operation but stresses the design of fixtures and tools rather than the method of making them. While the book is written for the tool designer, the link between the engineering department and the production job, it is clearly written, well illustrated, will be of wide interest and value to anyone using tools or machinery or designing machinery. Due to the needs of the Defense Program, particularly the training classes, this book is timely, because the demand for good tool designers greatly exceeds the supply. To increase the value of the book for home-study purposes or for class-room work, quiz questions have been added at the end of each chapter. The author is a consulting mechanical engineer and president of the Tool Equipment Sales Co. of Chicago.

How to Design and Install Plumbing. By A. J. Matthias, Jr. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in.; cloth bound; 124 pp. 2nd edition. Price $4.00.

This second edition differs from the first primarily in a great deal of entirely new material showing the application and design of typical plumbing systems in modern buildings, including a complete set of blueprints for a modern six room residence. While there is a great deal of historical material regarding the plumbing trade in the book, it is a very practical volume intended to serve the needs of students, journeymen, architects and tradesmen in other building fields.

It is intensely practical, gives the principles of design, shows how they are carried out in practice and tells how to handle all of the small details. In addition to this there is a 12 p. section devoted entirely to questions on the text material covered in the different chapters. The author is Circuit Instructor of Plumbing in the Wisconsin Vocational Schools, a licensed journeyman plumber and author of texts used in the University of Wisconsin Extension Division Courses as well as Wisconsin Vocational Schools.

NEMA Motor and Generator Standards. Published by The National Electrical Manufacturers Assn., 155 East 44th St., New York, N. Y., July 1941. Price $3.50.

The NEMA Motor and Generator Standards is a reference work of practical information concerning the manufacture, test and performance of alternating and direct current motors and generators, including combinations of both but excluding heavy traction motors for railroads, mining locomotive motors, arc welding generators, toy motors and generators and fans of the desk, bracket and ceiling type. This book, representing as it does standardized practice in the United States, assists in harmonizing practices in industry, promotes production economy and assists in the proper selecton of electric motors and generators. It is a book with a highly specialized purpose, tremendously valuable to those who have use for it but of little value to those who cannot make use of the Standards.

DISSTON meets tough feedwater problem with COCHRANE Deaerating Softener

New boiler house of Henry Disston & Sons, Inc., H. M. Wilson Co., Engineers & Constructors, Philadelphia.

View showing, above, the oil removal filter and two Cochrane-treated Water Filters and Sedimentation Tank of Cochrane Deaerating Hot Process Softener. Laboratory table in foreground.

AT the plant of Henry Disston & Sons, Inc., in Philadelphia, the normal power needs of this century-old manufacturer of saws, tools, files, knives and steel, plus the enormous defense load it has recently taken on, are amply provided for in the new high-pressure boiler plant just completed, in which a Cochrane Deaerating Softener and a Cochrane Continuous Blow-Off System are a part of the ultra-modern equipment.

The raw boiler water is river water with a hardness of 40 to 50 parts per million. It enters the softener at 60°F. from the heat exchanger of the Cochrane Continuous Blow-Off System and is treated with phosphate, the feeding of which is automatically controlled by a Cochrane Flow Meter. The treated make-up is deaerated by atomization in the softener. Condensate, after passing through a Cochrane Oil Removal Filter, is deaerated separately in the softener and joins the treated raw water at the feed pump. Heat from the boiler blow-off is recovered by a Cochrane Continuous Blow-Off System.

★ Many unique applications of feedwater treatment together with a discussion of Boiler Feedwater Analyses and Their Interpretation are included in Cochrane's handbook on Hot Process Softening, a copy of which will be mailed on receipt of coupon below.

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Please send me a copy of Cochrane Publication 3000 (Hot Process Softening).

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Fig. 0851
250 lbs. steam pressure

Instead of the usual wedge or disc, Fairbanks Sphero has a revolving ball plug which wipes the seating surface clean. Its shearing action cuts through heavy solids and liquids. There is nothing on which foreign matter can accumulate.

The opening in the ball plug is the same size as that in the pipe. There are no obstructions, no frictional resistance. It's clear sailing for steam, oil, water, etc.

Wear on seat rings is reduced to a minimum by the rotary motion of the ball. And seat rings can be kept permanently tight by adjusting the wedge at bottom.

It can be opened or closed as "quick as a wink" by the long lever handle. A positive stop tells when fully open or closed.

Seat rings or other parts which may become worn, can be replaced without removing valve from the line.

Try just one Fairbanks Sphero Valve for blow-off purposes and services where a full flow, quick-acting valve is desired and you'll wish you had used them before.

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Fairbanks Sphero Valves

How to Train Shop Workers. By C. A. Prosser and Philip S. Van Wyck. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago. Size 8½ by 11 in.; paper bound; mimeographed. Price $1.25.

This is a shop training manual for use by foremen and instructors in the training of workers in production and service jobs and as such is of particular interest at this time when industrial organizations are expanding so rapidly to meet the needs of the National Defense Program. It was originally produced for National Youth Administration training and has been expanded and adapted to the wider use of essential industries.

It is divided into six parts dealing with the foreman's duties and responsibilities; training the worker; teaching by job analysis; methods, procedures and devices; and the foreman as a human engineer. A great deal of material is presented in the form of charts, tables and lists of questions and answers. The authors are, respectively, director of the Dunwoody Institute and head of the metal trades department of Dunwoody Institute.

The New Encyclopedia of Machine Shop Practice. Edited by George W. Barnwell. Published by Wm. H. Wise & Co., Inc., New York, N. Y. Semi-flexible simulated leather binding, 561 pp., 5½ by 8½ in., copyright 1941. Price $1.98.

Nobody having occasion to operate a lathe or a shaper or milling machine, or who must at various odd times fashion metal into usable articles should be without this book. At the low price at which it is sold it is available to all, to the machinist apprentice and the master mechanic alike. It is a book that would be of value at any time but just now when the emphasis of the entire national production is on machine tool practice it is of immense importance. It covers every phase of machine shop work, from simple filing, which is not so simple if it is to be done well, to the operation of large boring mills. In it are detailed explanations of the operation of lathes, milling machines, shapers, centerless grinders, etc. Gear cutting, heat treatment, forge and foundry work are covered in an easy informative style. The entire book in fact is written in non-technical, clear, simple English that the layman can understand. In one chapter it gives a complete home study course on the use of hand tools. There is an excellent chapter on measuring and testing, and another one on machine drawing while the final chapter presents a carefully selected list of useful tables and data. Students and experienced machinists will find in this volume the answers to many questions that arise as to how things are made under the various present day procedure in metal working operations; of what they are made and why.

Professor Barnwell, who edited and compiled this book, is professor of production practice at Stevens Institute of Technology. In his work at Stevens he has turned out some very able young engineers and technicians over a period of years. As a consequence of this background this book is thoroughly up-to-the-minute.

Elements of Engineering Thermodynamics. By James A. Moyer, James P. Calderwood and Andrey A. Potter. John Wiley & Sons, Inc., New York, N. Y. 6 by 9 in., 217 pp.; hard bound cloth cover, copyright 1941. Price $2.50.

In the preface to this sixth edition, many parts of which have been rewritten since the other editions were published, the authors state that they have, as in former works, stressed the fundamental principles of engineering thermodynamics as a foundation for the more advanced and practical applications of the theory.

Being essentially a text book, many of the ideas and suggestions on the subject of thermodynamics, as brought out at the conference of mechanical engineering teachers held at Purdue University in 1939, under the auspices of the Society for the Promotion of Engineering Education, have been incorporated in this revision. The new material includes the thermodynamic treatment of uniform flow processes and new vapor tables. Reversible and irreversible processes are given additional attention. The book is elementary and each chapter closes with a list of typical questions.

Engineers will find this an excellent book to inform them of the latest ideas in this branch of engineering by means of which it is possible to predict the performance of steam engines and steam turbines when operating under conditions of increased pressure, of higher vacuum and expansions, of reheating the steam between stages, of extracting heat for feedwater heating and of using binary fluids.

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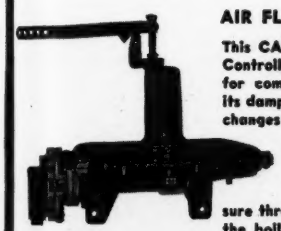
This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the Boiler uptake damper to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the fuel feed and air flow Controllers. If it only eliminated wasteful air infiltration it would be a profitable investment.

★ Bulletin No. 300 gives you a quick picture of the accuracy, simplicity, and dependability of CASH STANDARD Automatic Combustion Control. Send for your copy.



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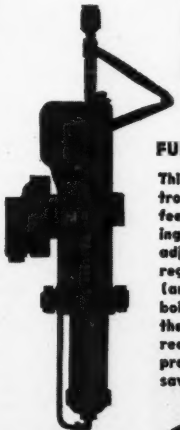
This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



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This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

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The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate with this CASH STANDARD Oil Circulator — price $108. equipped with 110-220 v. 60 cy. motor.

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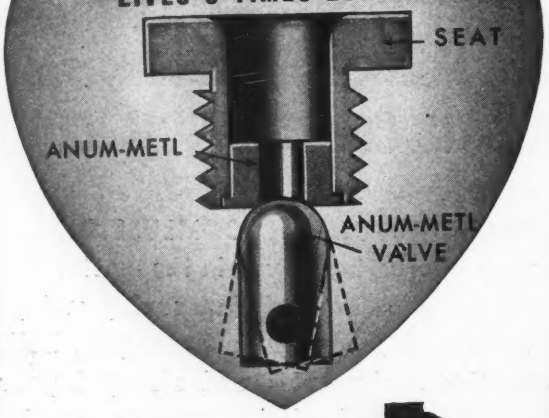

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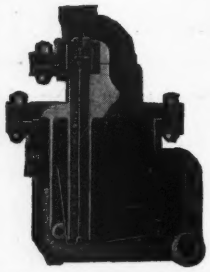
Diam. of leak	Lbs. steam wasted per 100 lb. press	Cost per mo. at 50c per M lbs.
¼"	203,000	$101.50
⅛"	50,500	25.25
1/16"	12,750	6.38
1/32"	3,175	1.58



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Steel Square Pocket Book. By Dwight L. Stoddard. Sixth edition. Scientific Book Corporation, 15 East 26th St., New York, N. Y. Size 4 by 6 in., 191 pp., flexible fabricoid. Price $1.00.

A handy pocket size "how to do it" book in compact form which offers a quick reference with simple and practical instructions for solving many every-day steel square problems. Complete illustration and description of the best practical methods of using the square in laying out all kinds of carpentry work are also included.

Simple instructions are also given for obtaining cuts for hoppers, towers, braces, trestles, stairs, bicycle tracks, etc., as well as for describing various figures such as octagons, circles, ellipses and ovals. Chapters included deal with practical applications; how to find different pitches and degrees; laying out common rafters; problems in hipped roofs, calculating by the square and numerous other applications of the steel square.

Marks' Mechanical Engineers' Handbook. Fourth Edition. Edited by Lionel S. Marks. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Semi-flexible imitation leather binding, 2276 pp., 4½ by 7 in., copyrighted 1941. Price $7.00.

Since the Third Edition of Marks' Mechanical Engineers' Handbook was published, eleven eventful years have passed. Years in which a vast amount of research and development work in the field of engineering has taken place and many standards of machine elements, of materials and of processes established. So this new edition is not merely a revision of the former work but an almost completely rewritten volume prepared by Mr. Marks and more than 90 specialists who have collaborated with him in presenting the newest developments and trends in mechanical engineering.

Both fundamental theory and the data of experiment and experience have been incorporated in this book in such a way as to make them conveniently useful to practicing engineers and students. This information is divided into the following 16 sections: Mathematical Tables and Weights and Measures; Mathematics; Mechanics of Solids and Liquids; Heat; Strength of Materials; Materials of Engineering; Fuels and Furnaces; Machine Elements; Power Generation; Hoisting and Conveying; Transportation; Building Construction ad Equipment; Machine Shop Practice; Pumps and Compressors; Electrical Engineering; and Engineering Measurements, Mechanical Refrigeration, etc.

Among the new subjects treated are the theory of models, plastic behavior of materials, stress concentration, creep, packings, wind pressure on structures, sound and noise, automatic control of processes, and powder metallurgy. Thus brought up to date, Marks' Handbook becomes a reliable authority on present-day mechanical engineering practice.

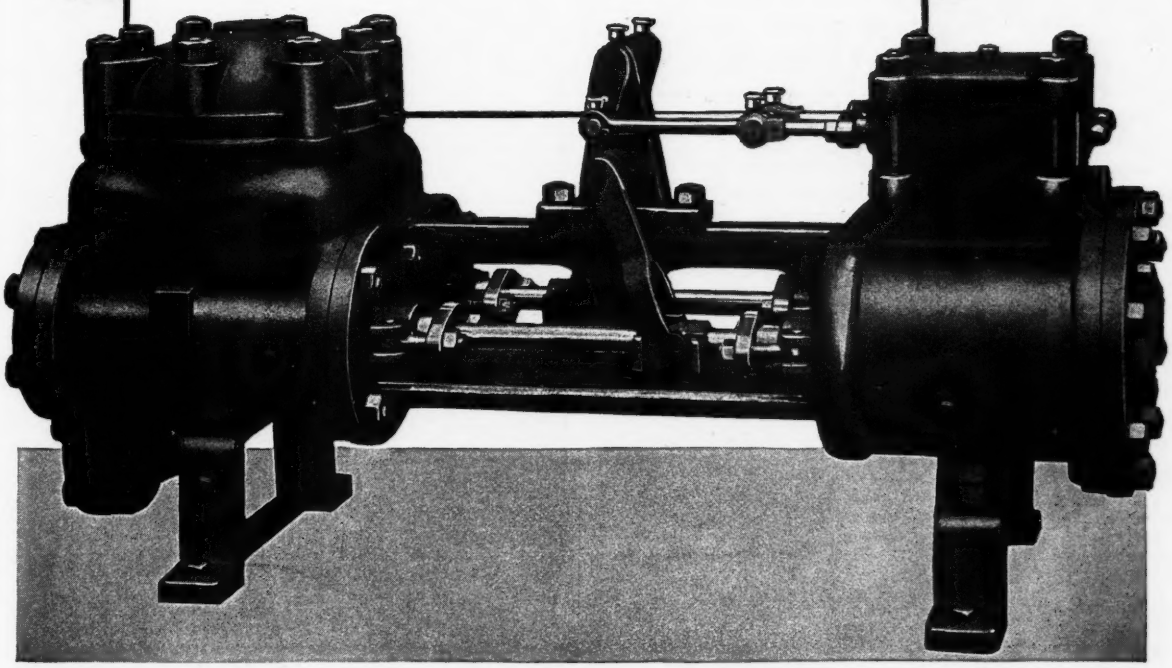
Hotel Engineering. Volume 2, Electric Current Consumption Costs and Savings. By Georges C. St. Laurent. American Hotel Association of the United States and Canada, 221 West 57th St., New York, N. Y. 8½ by 11 in., 44 pp., paper bound, copyright, 1941. Price $1.50.

This is the second of five books to be published on various phases of hotel engineering problems and economies and contains important information on all matters pertaining to electric current consumption, with excellent suggestions as to cutting costs and making worthwhile savings. Some of the topics discussed in the book are: Electric Current Rates; Diesel Engines for Hotels; Guest Room Air Conditioning Units; Fluorescent Lighting; Electric and Gas Cooking; Economy in Lighting; Savings on Elevator Operation; Central Cleaning Plant and Small Portable Units.

Statistics show what effect various factors have on the amount of electric current consumed such as size of hotel, amount of occupancy, amount of air conditioning, number of elevators and the operation of a kitchen and laundry. The book describes how a hotel operator may conduct his own survey of the electric operations in his hotel and lists on a number of pages, various ideas for eliminating waste and lowering the hotel's electric expense. The proper approach to the electric company rate problem is discussed, together with other important problems such as electric generation compared with purchased electric current. Written in non technical language, the book is of particular value to managers in giving them general engineering information from which to judge the value of services rendered by the power plant.

WARREN PUMPS

LICK THE TAR OUT OF A TOUGH PROBLEM



Quite frequently pumping problems are encountered that give plenty of trouble and expense until a Warren engineer is called in. A typical example, of how a difficult pumping situation was made right, took place when a certain company installed a Warren Pump to handle tar, at a rate of 40 gallons per minute. The tar was so heavy it had to be heated to flow, yet after nearly two years of continuous service, the pump is still "performing excellently."

If you have a pumping problem give Warren a chance to "lick the tar" out of it for you. Just ask for a Warren representative to call.

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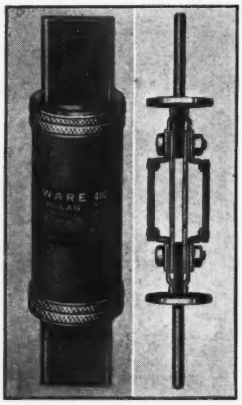
Faulty link contacts in fuses are one of the major problems which cause delay and production interference according to a recent industrial survey. Yet you definitely put to an end all Vibration, Heating and Cooling worries when you install WARE HI-Lag FUSES.

The Improved Assembly Construction of WARE FUSES provides a DOUBLE SURFACE Spring Tension CONTACT on links, using two heavy wide spring steel washers and large steel bolt, all cadmium plated, to fasten and produce a PERFECT CONTACT under all conditions.

The Double Fibre Bridge for Alignment and strength, also permits links being centered in all casings. The bolt screws lock so that only one wrench is needed.

WARE LINK DESIGN produces lag characteristics found in no other fuse: fast opening on short circuits—expansion without sharp bending—heat absorption of motor starting current, and short heavy surges and square design for increased contact area and heat reduction.



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Glass: The Miracle Maker. By C. J. Phillips. Published by Pitman Publishing Corporation, New York, N. Y. Size 6 by 9 in.; 436 pp.; 264 illustrations; cloth bound. Price $4.50.

This only comprehensive book on glass covers history, manufacture, chemistry, physical and mechanical properties and applications. Hitherto no book has treated more than a phase or two of glass and there has been almost nothing on the countless vital applications.

As a source of suggestions for new products and improved production methods, many of them essential in defense, this book meets the needs of engineers, industrial designers, executives and students. For general readers it is, even without the three more technical chapters on chemistry and mechanical and physical properties, a complete and understandable story. For executives and workers in glass plants it clearly gives a detailed picture of manufacture and technology.

The author first treats hand glass processes and then proceeds to the more involved machine processes. His is the most extensive available material on mechanical properties. Of the chapters on application, those on Glass and Illumination stand out as comprehensive. Also included is a complete, separate chapter on Fiberglas.

Heat Engines. By John R. Allen and Joseph A. Bursley. Fifth Edition, Published by McGraw-Hill Book Co., Inc., New York, N. Y., 1941. Hard cloth binding, 576 pages, 6 by 9 in. Price $4.00.

As an elementary treatise upon the subject of heat engines which includes steam, gas, and oil engines, steam turbines and their auxiliaries, this book was primarily intended to be a text book in engineering colleges and includes typical problems which engineers are called upon to solve in their practice of the profession. So far as is possible for a thorough understanding of the subject, caculus and other higher mathematics have been avoided and the book tends more toward the practical application of engineering principles than it does toward theoretical considerations.

In this latest edition made necessary by the developments that have taken place in recent years, particular attention has been given to boiler auxiliaries, steam turbines, and internal combustion engines with rewritten text and new illustrations on these subjects. The old chapters on compound engines, valve gears and governors have been abridged and incorporated in other chapters. A new chapter on air compressors and refrigerating machinery has been added.

The student will find in this book a clear explanation of the process of converting heat into mechanical power and the equipment used in modern practice for this purpose, and the practicing engineer will find it beneficial in bringing his fundamental information up to date as well as a convenient reference authority.

Boiler Auxiliaries. Published by the Edison Electric Institute, 420 Lexington Ave., New York, as Publication No. I-4. Size 8½ by 11 in., 44 pp., paper bound. Price $0.80 to members, $2.00 to non-members in U. S. A.; $2.15 foreign.

This is the first report of the Boiler Auxiliaries Subcommittee of the Prime Movers Committee dealing with current operating and design problems in connection with various boiler plant auxiliaries such as: fans; couplings; dust collectors; coal and ash handling; breechings; chimneys; boiler feed pumps; and fuel oil heaters. The report is divided into 11 main sections, each consisting of a committee statement or summary followed by operating company and manufacturers statements. Some of these sections deal with miscellaneous operating companies; others deal with specific problems which are more or less widespread. An example of this last is in connection with forced and induced draft fans which is devoted primarily to three current problems: vane control, erosion and vibration.

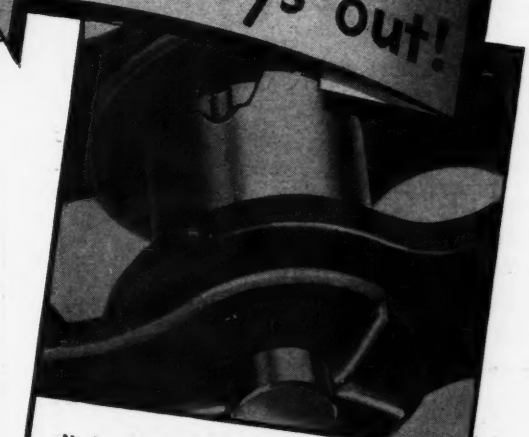
Inventors Wanted. For engineers or inventors who desire to aid in national defense, Inventors Council of the Dept. of Commerce is issuing an Information Bulletin No. 2. This states the purpose, to encourage submission of inventive ideas to the Council, prompt evaluation by a staff of engineers, and placing of useful ideas in the hands of proper military and naval bureaus. Character of useful inventions is outlined, procedure for submitting ideas is suggested, instructive literature on various subjects is listed and names of the Council members are given. Copies may be obtained from National Inventors Council, Dept. of Commerce, Washington, D. C.

Hundreds of "Automatic Oilers" KEEP THIS CHAIN OPERATING!

There's a tough baby, that Morse Roller Chain. It's made of special steel alloys, heat treated to bring out its strength and durability. It's strong enough to walk through overloads, take sudden shocks in its stride.

And it doesn't "soften up" in a hurry either. The automatic oilers (oil channels in the bushings which guide oil right down to the heart of the links) lead oil in and wear stays out of the pin and bushing surfaces, where ordinary roller chain failures frequently occur.

For industrial jobs requiring rugged power transmission, you will like strong, long-lived Morse roller chain. All sizes and capacities, single and multiple widths. Get Morse interchangeable, channel lubricated roller chain!



No longer do Roller Chains "work their hearts out" on the job. For in Morse Roller Chain the heart of the chain is protected with a life-preserving film of oil, flowing there through channels from the bushings. Oil gets in—wear stays out!

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

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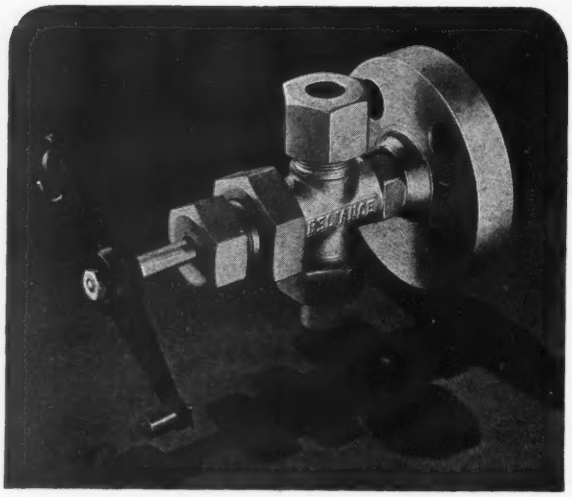

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Valve body is forged steel, is available with flange of any ASA series or any special design, welded to the shank. Extra deep stuffing boxes use moulded metalastic packing rings at stem and glass ends—assure leak-tight assembly. Reliance Gage Valves save expense and annoyance on thousands of boilers. Write for Bulletin 401 *now!*

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Coupon for obtaining free literature listed here may be found on page 150, under the heading Helpful Bulletins.

Instruments and Controls

1 Recorder Charts—In TAG catalog No. 1230 are illustrated charts for all temperature ranges, for vacuums and pressures, for spring driven and electric clocks. C. J. Tagliabue Mfg. Co.

2 Pressure Gages—Bulletin No. 3-5 illustrates and describes the rectangular case bourdon tube pressure gages. Lock-Tite sealing of the ends of tubes prevents affecting the calibration of the tube. Heavy construction, with dissimilar metals at bearing surfaces give accuracy and long life. The Brown Instrument Co.

3 Combustion Control—No. 8 of a series is the adaptation to characteristics of Gas Burners which is discussed in a monograph by William H. Pugsley, Manager of Engineering. The Hays Corporation.

4 CO_2 Instruments—Ranarex Instruments for measuring CO_2 in flue gases, specific gravity of gases, quality of furnace atmospheres, engine exhaust gas composition and special uses are treated in Bulletin R 40. The bulletin also gives valuable information on the principles governing the burning of coal, oil and gas. Permutit Co.

5 Flow Meters—Ring Balance meters for all fluids; their operating principle and construction are described and illustrated in Bulletin No. 411. Ring Balance Instrument Co.

6 Gages—Thermometer and Pressure Gauge Accessories is the title of a 24 pp. catalog describing Brown thermometers, hygrometers and pressure gages. Specifications and operating principles of the numerous types and models of instruments are fully covered. Illustrations of the various accessories including bulbs, tubing extension necks, separable sockets, wrought iron sockets and fittings, wet and dry bulb assemblies, pulsation checks, oil seals, gage cocks and charts are included; also sections on application, arrangement and connections. Brown Instrument Co.

Electrical Equipment

7 Transformers—To give constant voltage at delivery points, regardless of supply line voltage variations, Sola transformers are described in a 22-pp. Bulletin CV-74. The Sola Electric Co.

8 Switchgear—Unitized switchgear which consists of 13 basic units to meet 600 v. main and feeder requirements for use in central stations, industrial plants and commercial buildings, are described in a new 25-pp. booklet B-2296. Westinghouse Electric & Mfg. Co.

9 Switches—For various forms of make-break-make switching Bulletin 61 illustrates and describes the construction and action in capacities of 10 and 20 amp. at 110 v. Donald P. Mossman, Inc.

10 Power Factor Chart—Bulletin GES-2765 gives a chart for determining power factor from line current, with and without Pyranol capacitors connected. Reverse side shows types of Pyranol capacitors. General Electric Co.

Pumps and Compressors

11 Chemical Pumps—A 16-pp. catalog illustrates, describes and gives specifications of Milton Roy Pumps for handling chemicals in precisely-controlled quantities, from as little as 1 pt. per hr. up to 2000 gal. per hr. Heavy-duty pumps capable of operating against pressures up to 20,000 lb. per sq. in. Also included is a new pump made from transparent plastics. Milton Roy Pumps.

12 Centrifugal Compressor—In a new 20-pp. catalog No. 458, illustrated with installation photographs in a wide variety of plants, is described the latest designs in large-volume, high-pressure centrifugal compressors. All important phases in design, construction and application are covered. Also included is information on application, methods of drive, lubrication and control, together with a discussion of the factors involved in effecting power economies,

How to Boost Wiring Capacity Without Rewiring

IMPROVE POWER-FACTOR WITH G-E PYRANOL CAPACITORS

Easy to install in out-of-the-way locations. Space-saving overhead racks could be used because Pyranol (the treating liquid in these capacitors) is noninflammable.

"With a total expenditure of less than $13,000, our savings have averaged $1,000 monthly, which is better than expected. In addition, we have had no maintenance expense." This is the profitable experience of the Murray Corporation of America, Detroit, after increasing the capacity of the plant distribution system with 1440 kva of G-E Pyranol capacitors.

You get—

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Does your plant use induction motors? Induction furnaces? Then the chances are that the power-factor is low—that your circuits are "clogged up" with a lot of reactive (nonworking) current. And that means that you can greatly increase the capacity of your existing wiring simply by installing G-E Pyranol capacitors on the lines. They neutralize reactive current and so permit the entire system to carry more *useful* current for additional motors and other equipment.

Equally important—if your power contract contains a power-factor-penalty or kva-demand clause, you will realize direct savings in reduced power cost that may *pay for the capacitors in from one to three years.* And the savings continue as a highly profitable return on the investment.

Ask your G-E representative for a quick estimate of the increase in capacity and the savings possible with Pyranol capacitors. Popular ratings are carried in stock for prompt delivery. We ship directly from the warehouse shelf.

Write for Bulletin GEA-77. General Electric, Schenectady, N. Y.

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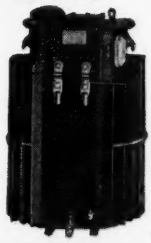
Over-loaded circuits mean low voltage and inefficient operation of motors and lamps. G-E air-cooled induction voltage regulators will bring performance back to standard. And indoor installations are easy to make—no vault is required. (Bulletin GES-2285)



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wide range of volumes at constant pressure, and quiet operation with minimum maintenance cost. B. F. Sturtevant Co.

13 **Pumps**—Thrustfre, 2 and 3-stage centrifugal pumps with details of construction in capacities of 50 to 850 g.p.m. and for heads up to 1050 ft. are illustrated and described in Bulletin No. 237. Pennsylvania Pump and Compressor Co.

Heating and Piping Systems

14 **Unit Heaters**—History of the development and progress of industrial plant heating and much valuable information for anyone in the heating field, whether architect, engineer, contractor or plant operator, manager or business executive is contained in Bulletin HR-1. L. J. Wing Mfg. Co.

15 **Heating**—Systems for low pressure, with natural and forced draft and various types of grates are illustrated and described in a recently released circular. The McClave Co.

16 **Valves**—Catalog 70, Bulletin 23 illustrates and describes operation, installation, and directions for dismantling and reassembling. Relief Valve 37-R5 of Duplex Back Pressure Valve and Vacuum Breaker 34-R17. Foster Engineering Co.

17 **Traps**—Recently released Circular D illustrates and describes improved return traps for boiler feeding and pumping draining vacuum lines and creating vacuum on low-pressure return lines. Made in cast iron sizes from 1 to 2½ in., they can be used for any pressure up to 200 lb. Templeton Brothers, Inc.

Water Conditioning

18 **Cooling Waters**—Covered in a 46-pp. booklet are the subjects of scale, corrosion, and living organisms in cooling waters as discussed by well-known authorities. In this series of articles are discussed effects in atmospheric cooling systems, condensers, water systems, with suggestions for corrosion prevention and use of film inhibitors. D. W. Haering & Co., Inc.

19 **Water Treatment**—In a 48-pp. booklet of articles on scale, corrosion and water treatment are given problems from a selection of interesting and popular discussions. Profusely illustrated with tables, charts and graphs, the booklet also covers water problems occurring in cooling systems, hot water systems, boilers, and return systems including data on corrosion inhibitors, scale preventives, protective coatings, proportioning equipment and refrigerating brine problems. D. W. Haering & Co., Inc.

20 **pH Control**—What is pH, how measured, how used in control of water alkalinity or acidity? These are explained in a pamphlet titled What Every Executive Should Know About pH. National Technical Laboratories.

21 **Water Handling**—New edition of a 20-pp. manual on de-scaling and the maintenance of water circulating and cooling equipment, describes Oakite Compound No. 32 and gives data on water cooling for combustion engines, compressors and transformers. Oakite Products, Inc.

22 **Scale and Corrosion Control**—Organic Methods of Scale and Corrosion Control is the title of a recently released 28-pp. revised booklet. Charts, graphs, tables and photographs illustrate the usefulness of organic chemicals in water conditioning and point the way to substituting these efficient and available chemicals for producs which are difficult to obtain. A new section tabulates the physical and chemical properties of the various glucosates developed by Haering Research, with several pages devoted to analytical and control test procedures. D. W. Haering & Co., Inc.

Miscellaneous

23 **Ejectors**—A new 32 pp. Bulletin G-7 on Steam Jet Ejectors contains a complete and well illustrated discussion of ejectors including the theory and operation of both single-stage and multi-stage ejectors; characteristics, selection and application; and curves of air and water vapor mixture data and a pressure-temperature conversion table. The Elliott Co.

24 **Texrope Sheaves**—Full descriptions of Allis-Chalmers Texsteel and Texdrive Sheaves, steel and cast iron sheaves for Texrope Drives from fractional to 25-hp., are presented in Bulletin B-6047. Handy tables in the book

For every industrial service there is a JOHNS-MANVILLE INSULATION specially designed to provide highest operating efficiency, long life and maximum fuel savings - - -

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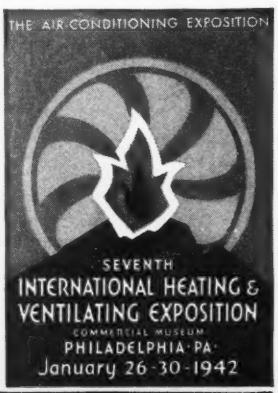
With progressive industrial expansion reaching ever mounting peaks, it has been forecast that the average level of business will reach the highest production point of a hundred years. What an opportunity for all who can help solve the pressing problems connected with public health, comfort and efficiency! What an opportunity for every engineer. What an incentive to see the 7th International Heating and Ventilating Exposition—the Air Conditioning Exposition—at Philadelphia in January!

Never before was there so much to be learned quickly, never such need to revise ideas, never a greater opportunity to apply knowledge with profit to the Nation and self at the same time.

How well equipped are you to help solve the heating, ventilating and air conditioning problems of the day? A visit to this Exposition will show you where you stand, bring you up to date, enable you to act with the certainty of knowledge extended and confirmed.

Plan definitely to attend this Exposition—with your associates.



7th INTERNATIONAL HEATING & VENTILATING EXPOSITION

The Air Conditioning Exposition

COMMERCIAL MUSEUM • PHILADELPHIA • JANUARY 26-30, 1942

Under the Auspices of American Society of Heating and Ventilating Engineers

MANAGED BY INTERNATIONAL EXPOSITION COMPANY 777

list available sizes, various dimensions and list prices. A section is also devoted to the new Texrope Super-7 V-belts. Allis-Chalmers Mfg. Co.

25 **Speed Transmission**—In the recently released Graham Dial are brief abstracts of outstanding articles on metallic traction and variable speed transmission. Graham Transmissions, Inc.

26 **Materials Handling**—In bulletin, Vol. 188, plants are described for handling sand, stone, explosives, coal, oils, gravel, wood waste, cereals and various other products. Also included are numerous illustrations. Stephens-Adamson Mfg. Co.

27 **Insulating Concrete**—A recently released bulletin gives detailed information on mixing and placing cold-setting, monolithic refractory. It also shows availability of Refractory Insulating Concrete for industrial furnace construction, with charts of hot and cold face temperatures and heat loss for different thicknesses of walls. Atlas Lumnite Cement Co.

28 **Wire Screen**—Woven Wire Screen Cloth is the title of Bulletin No. 113 which gives the requisite qualities of screen material, illustrates various construction of screens and tells how to select the proper screen for any purpose. Robins Conveying Belt Co.

29 **Iron Cements**—For repairs in homes, power plants, on autos, motor boats, etc., Smooth-On Cements are described and illustrated in a 40-pp. pocket handbook, which also includes concrete paint and gaskets. Smooth-On Mfg. Co.

30 **Diesel Engines**—In Bulletin S-500-B38A are illustrated and described Worthington 4-cycle, direct-injection, totally enclosed DD Diesel engines, giving details, sizes and horsepowers. Worthington Pump and Machinery Corp.

31 **Power Plants**—Custom planned power plants to meet the conditions for economical operation in each plant, as designed by Burns & McDonnell Engineering Co. are described and illustrated in a recently released handsome colored booklet. Burns & McDonnell Engineering Co.

32 **Nickel Alloys**—Individualized Inco Nickel Alloys is a 12 pp. catalog giving individual characteristics, mechanical properties and application information on the Inco Nickel Alloys—Monel, K Monel, KR Monel, S Monel, R Monel, Nickel, Z Nickel and Inconel. Tables of physical constants and available forms are included. The International Nickel Co., Inc.

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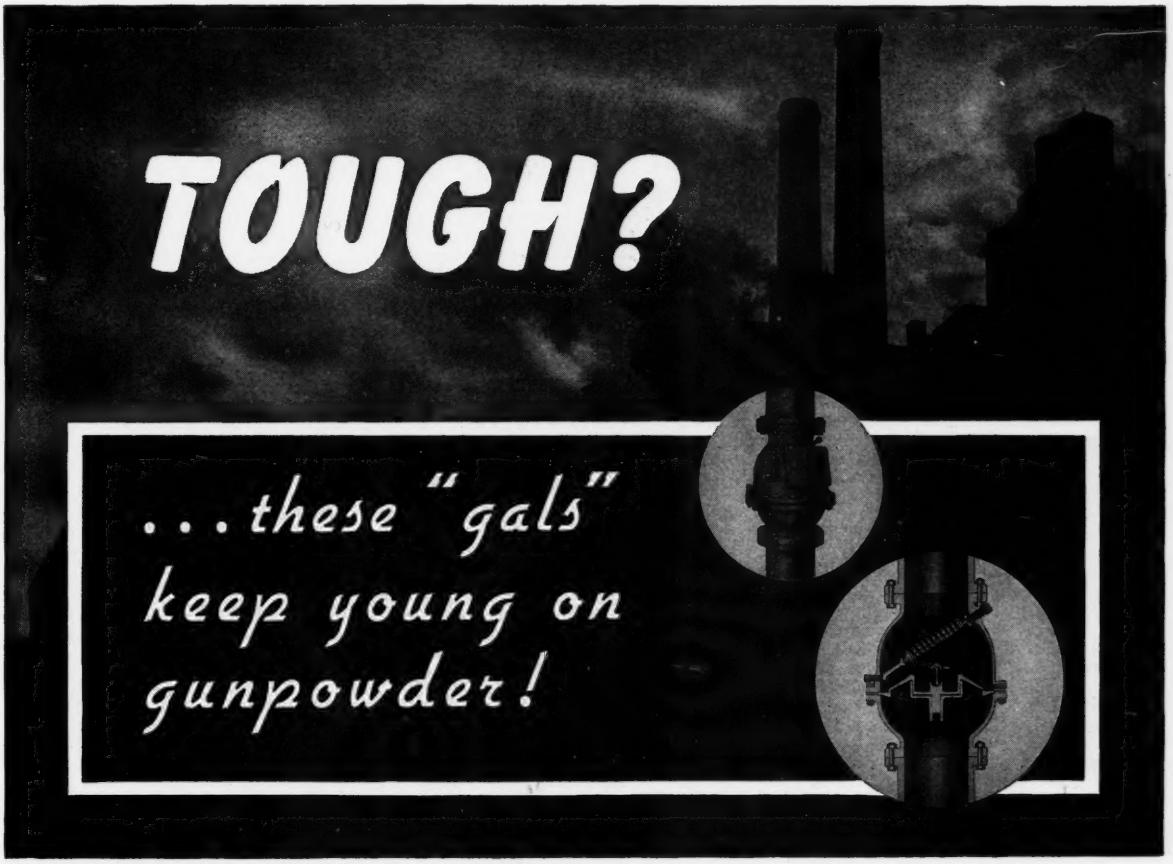

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11-FE-2

Power Plant Construction News

Ala., Greenville—Alabama Electric Co-operative, Inc., Montgomery, Ala., has plans under way for new steam-electric generating station on site now being selected in vicinity of Greenville (Butler County), to be used for power supply to a group of about 10 rural electric distribution co-operative organizations in that part of Alabama and in Florida. Cost estimated about $2,500,000, including transmission lines. Fund in that amount is being secured through Federal aid. Gordon Persons & Co., 200 Montgomery Street, Montgomery, are consulting engineers.

Calif., Los Angeles—Phelps-Dodge Copper Products Corp., 40 Wall Street, New York, N. Y., plans installation of electric power equipment in new branch plant on about 41-acre tract of land on Compton-Jaboneria Road, Los Angeles, for production of condenser tubing for Government. It will comprise several large one-story units. Cost about $3,000,000. Plant will be Government-owned, and fund in amount noted will be furnished by Defense Plant Corp., Washington, D. C., a Federal agency, for project.

Conn., Hartford—Hartford Electric Light Co., Hartford, has filed plans for proposed addition to South Meadow steam-electric generating station, and will proceed with superstructure at once. Cost estimated $610,000, exclusive of equipment. Company recently arranged a bond issue of $4,500,000, the majority of proceeds to be used for this project. Installation will include a new 45,000-kw. turbine-generator unit, high-pressure boilers and auxiliary equipment.

Fla., Clewiston — United States Sugar Corp., Clewiston, plans installation of electric power equipment in new plant unit for the production of starch, using sweet potatoes as raw material. It will comprise several large buildings, estimated to cost over $2,500,000, with machinery and equipment. Proposed to begin work soon.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams Street, will proceed with superstructure for addition to Fisk Street steam-electric generating station at 1101-11 Cermak Road, for expansion in steam department and switching gallery. A building permit has been issued for work. Cost about $200,000, exclusive of equipment. Shaw, Naess & Murphy, 80 East Jackson Boulevard are architects.

Iowa, Des Moines—Marquette Cement Mfg. Co., 140 South Dearborn Street, Chicago, Ill., has approved plans for new boiler house, 40 by 80 ft., at packing plant at S. W. Fifty-second and Park Streets, Des Moines. Work is scheduled to begin at once. Cost over $65,000 with equipment. J. L. McConnell, 53 West Jackson Boulevard, Chicago, is consulting engineer.

Iowa, Ottumwa—John Morrell & Co., Ottumwa, meat packers, plan installation of electric power equipment in new 7-story addition for expansion in processing and canning departments. Cost reported over $175,000. Henschien, Everds & Crombie, 59 East Van Buren Street, Chicago, are architects and engineers. Work will begin soon.

Kan., Crestline — Chemical Construction Corp., Rockefeller Plaza, New York, N. Y., has been awarded contract by War Department, Washington, D. C., for design and construction of new synthetic ammonia plant on 1900-acre tract of land at Baxter Springs, near Crestline, recently referred to in these columns. A steam power house will be built. Electric power equipment will be installed for works operation. Plant will be operated by Military Chemical Works, Inc., recently organized subsidiary of Pittsburg & Midway Coal Co., 1004 Baltimore Street, Kansas City, Mo., instead of Miners Chemical Works, as previously announced. Entire project will cost about $20,000,000. Work will begin soon.

Kan., Lindsborg—Municipal Water and Light Plant plans extensions and improvements, including installation of new engine-generator unit and auxiliary equipment. Proposed to hold special

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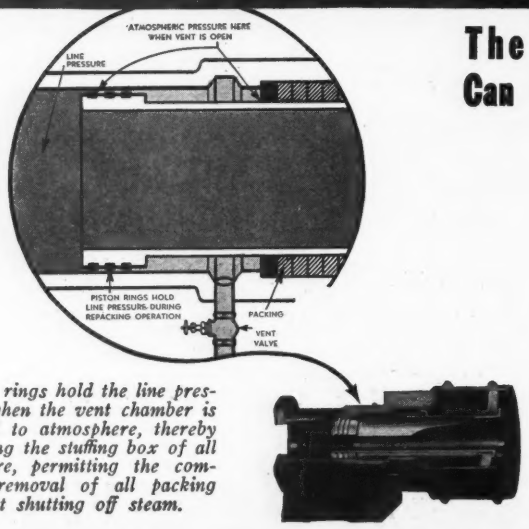
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election soon to vote bonds for $105,000 for project.

Md., Baltimore—Benjamin J. Kavanaugh, 1100 Hartford Avenue, operating a rendering works for production of greases, fats, etc., plans new boiler house, about 30 by 40 ft., in connection with new 2-story plant addition. New boiler unit and auxiliary equipment will be installed. Entire project is estimated to cost close to $50,000. Harry L. Katz, 3212 Gwynns Falls Parkway, is architect.

Mass., Fitchburg—Fitchburg Gas & Electric Light Co., Main Street, has approved plans for addition to local steam-electric generating plant for expansion in steam division. New equipment will be installed for increased capacity. No estimate of cost announced. Work is scheduled to begin at once.

Mich., Grand Rapids — Extruded Metals Defense Corp., Belding, Mich., recently organized subsidiary of Extruded Metals, Inc., same place, plans installation of electric power equipment in new plant at Grand Rapids, for production of aluminum alloy products for Government. It will total about 250,000 sq. ft. of floor space and will cost $6,266,000, of which approximately $4,000,000 will be used for machinery and equipment. Fund in amount noted will be secured through Defense Plant Corp., Washington, D. C., a Federal agency, for project.

Neb., Gothenburg — City Council has authorized plans and estimates of cost for a proposed municipal power plant. Arthur Weideranders is city engineer, in charge.

Neb., Omaha — Metropolitan Utilities District, Eighteenth and Harney Streets, has approved plans for new boiler plant for use in connection with gas works, and will carry out erection with own forces. Cost reported close to $50,000.

N. Y., Wheatfield — Bell Aircraft Corp., 2050 Elmwood Avenue, Buffalo, N. Y., manufacturer of airplanes and parts, plans installation of electric power equipment in new additions to branch plant at Wheatfield, near Niagara Falls airport, totaling over 750,000 sq. ft. of space. A new boiler house will be built. Entire project will cost about $8,456,200. Production will be for Government, which will furnish fund in amount noted through Defense Plant Corp., Washington, D. C., a Federal agency for project.

Ohio, Lorain—City Water Department plans installation of two new boiler units and auxiliary equipment in municipal waterworks station. Cost estimated about $60,000. Proposed to ask bids at early date.

Pa., Aliquippa—National Can Co., 110 East Forty-second Street, New York, N. Y., plans installation of electric power equipment in new plant at Aliquippa, where tract of about 2 acres of land has been acquired. Entire project is reported to cost in excess of $375,000.

Pa., Chester—Penn Steel Casting Co., Front and Penn Streets, plans installation of electric power equipment in connection with rebuilding of portion of plant recently destroyed by fire. Loss reported over $350,000.

Pa., Erie—Erie Lighting Co., 21 West Tenth Street, plans expansion in local steam-electric generating station on Front Street, with installation of new turbine-generating unit, high-pressure boiler and auxiliary equipment. Also, will make extensions in transmission lines. Entire project is reported to cost over $2,500,000.

Pa., Johnstown — Bethlehem Steel Co., Bethlehem, Pa., has plans under way for extensions and improvements in power plant at mill at Johnstown, with installation of additional equipment for increased capacity. Cost reported over $150,000, with equipment.

Texas, Dallas—Dallas Arctic Locker & Provisions Co., recently organized, has selected site at 4531-37 McKinney Street, near Knox Street, for new one-story cold storage and refrigerating plant, with locker facilities. Cost estimated about $55,000, with equipment. Proposed to begin work soon.

Texas, Freeport — Dow Chemical Co., Inc., Midland, Mich., plans installation of electric power equipment in new plant in vicinity of Freeport to be used for production of metallic magnesium for Government. It will comprise several large processing units and auxiliary structures, and will be operated in conjunction with existing works of company at same place. Cost estimated at $52,000,000. Project will be Government-financed through Defense Plant Corp., Washington, D. C., a Federal agency.

Wis., Waterloo—Water and Light Commission plans rebuilding and improvements in steam-electric generating station, with installation of new 750-kw. turbine-generator unit, 330-hp. boiler and auxiliary equipment. Cost estimated close to $100,000. Application has been made for permission. Commercial Testing & Engineering Co., 307 North Michigan Avenue, Chicago, Ill., is consulting engineer.

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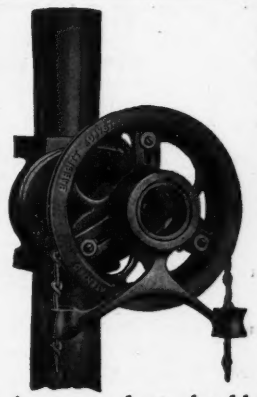

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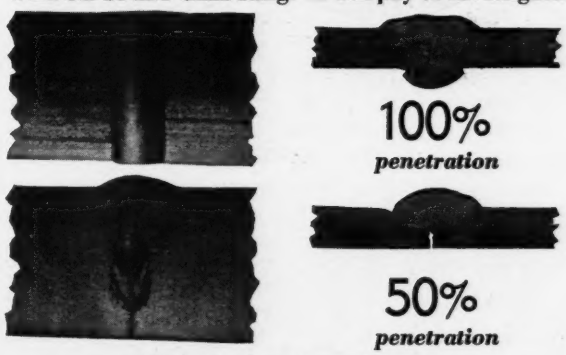

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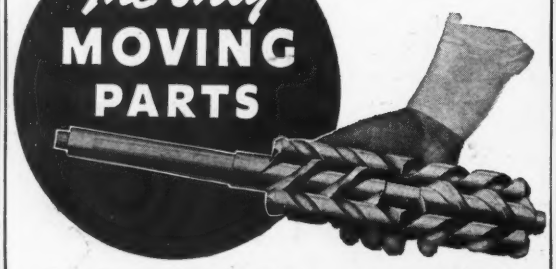

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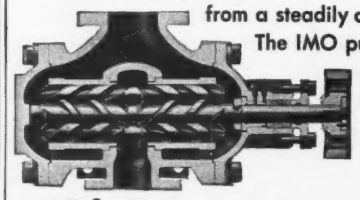

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